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(54) **HETEROARYLPIPERIDINE AND-
PIPERAZINE DERIVATES AS FUNGICIDES**

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1, 2011.

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CPC **A01N 43/80** (2013.01); **C07D 417/04**
(2013.01); **C07D 417/14** (2013.01)

(58) **Field of Classification Search**

CPC C07D 417/04; C07D 417/14; A01N 43/80
USPC 546/211, 208, 209; 514/326
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,245,432	A	1/1981	Dannelly	
4,272,417	A	6/1981	Barke et al.	
4,808,430	A	2/1989	Kouno	
5,876,739	A	3/1999	Turnblad et al.	
8,501,781	B2 *	8/2013	Cristau et al.	514/326
8,642,634	B2 *	2/2014	Pasteris et al.	514/365
8,815,775	B2 *	8/2014	Cristau et al.	504/249
2003/0176428	A1	9/2003	Schneidersmann et al.	
2010/0137245	A1	6/2010	Cristau et al.	
2010/0190828	A1	7/2010	Cristau et al.	

2011/0105429	A1	5/2011	Cristau et al.
2011/0124501	A1	5/2011	Cristau et al.
2011/0224257	A1	9/2011	Cristau et al.
2011/0301197	A1	12/2011	Cristau et al.
2011/0306620	A1	12/2011	Cristau et al.
2011/0312999	A1	12/2011	Cristau et al.
2012/0065197	A1	3/2012	Cristau et al.
2012/0122928	A1	5/2012	Tsuchiya et al.
2012/0122929	A1	5/2012	Tsuchiya et al.
2012/0245204	A1	9/2012	Hoffman et al.
2013/0090477	A1	4/2013	Cristau et al.

FOREIGN PATENT DOCUMENTS

DE	10 2010 000 662	A1	10/2010
JP	60-156601	A	8/1985
WO	WO 96/33270	A1	10/1996
WO	WO 02/28186	A2	4/2002
WO	WO 02/080675	A1	10/2002
WO	WO 2004/058751	A1	7/2004
WO	WO 2005/003128	A1	1/2005
WO	WO 2005/040159	A1	5/2005
WO	WO 2006/084015	A2	8/2006
WO	WO 2006/106423	A2	10/2006
WO	WO 2006/117521	A1	11/2006
WO	WO 2007/014290	A2	2/2007

(Continued)

OTHER PUBLICATIONS

Pasteris et al. "Fungicidal azocyclic amides" CA148:185135
(2008).*

Bach, T. and Heuser, S., "Regioselective Cross-Coupling Reactions
as an Entry into Biologically Relevant Bithiazoles: First Total Syn-
thesis of Cystothiazole E," *Angew. Chem. Int. Ed.* 40(17):3184-3185,
Wiley-VCH Verlag GmbH, Weinheim, Germany (2001).

Ballard, P., et al., "Neutral 5-substituted 4-anilinoquinazolines as
potent, orally active inhibitors of erbB2 receptor tyrosine kinase,"
Bioorganic & Medicinal Chemistry Letters, 17:6326-6329, Elsevier
Ltd., England (2007).

(Continued)

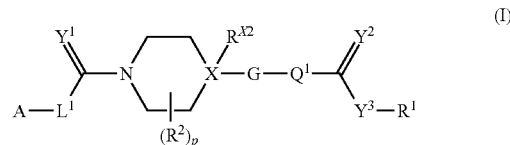
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(57)

ABSTRACT

Heteroaryl piperidine and -piperazine derivatives of the for-
mula (I)



in which the symbols are each as defined in the description,
and agrochemically active salts thereof, and use thereof for
controlling phytopathogenic harmful fungi, and also pro-
cesses for preparing compounds of the formula (I).

2 Claims, No Drawings

(56)

References Cited

FOREIGN PATENT DOCUMENTS

WO	WO 2007/024782	A2	3/2007
WO	WO 2007/027777	A2	3/2007
WO	WO 2007/103187	A2	9/2007
WO	WO 2008/013622	A2	1/2008
WO	WO 2008/013925	A2	1/2008
WO	WO 2008/091580	A2	7/2008
WO	WO 2008/091594	A2	7/2008
WO	WO 2008/104077	A1	9/2008
WO	WO 2009/055514	A2	4/2009
WO	WO 2009/094407	A2	7/2009
WO	WO 2009/094445	A2	7/2009
WO	WO 2010/065579	A2	6/2010
WO	WO 2012/055837	A1	5/2012
WO	WO 2012/082580	A2	6/2012
WO	WO 2012/092115	A1	7/2012

OTHER PUBLICATIONS

- Barany, G., et al., "A General Strategy for Elaboration of the Dithiocarbonyl Functionality, —(C=O)SS—: Application to the Synthesis of Bis(chlorocarbonyl)disulfane and Related Derivatives of Thiocarbonic Acids," *J. Org. Chem.* 48:4750-4761, American Chemical Society, United States (1983).
- Chen, W., et al., "The Design and Synthesis of Bis(thiourea) Ligands and Their Application in Pd-Catalyzed Heck and Suzuki Reactions Under Aerobic Conditions," *Eur. J. Org. Chem.* 1177-1184, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany (2006).
- Coleridge, B.M., et al., "General and user-friendly protocol for the synthesis of functionalized aryl- and heteroaryl-cyclopropanes by Negishi cross-coupling reactions," *Tetrahedron Letters* 50:4475-4477, Elsevier Ltd., England (2009).
- Collins, D.J., et al., "Organophosphorus Compounds. XVIII Synthesis of 2-Phenyl-2,3-dihydro-1H-1,2-benzazaphosphole 2-Sulfide by Pyrolysis of (2-Aminobenzyl)phenyldithiophosphinic Acid," *Aust. J. Chem.* 36:2095-2110, Commonwealth Scientific and Industrial Research Organization, Australia (1983).
- Dondoni, A. and Merino, P., "Thiazoles" in *Comprehensive Heterocyclic Chemistry II*, vol. 3 pp. 373-474, Elsevier Ltd., England (1996).
- Dondoni, A., et al., "A New Convenient Preparation of 2-, 4-, and 5-Thiazolecarboxaldehydes and Their Conversion into the Corresponding Carbonitrile N-Oxides: Synthesis of 3-Thiazolyl-isoxazoles and 3-Thiazolylisoxazolines," *Synthesis*, 11:998-1001, Thieme Stuttgart, Germany (1987).
- Draber, W., "Chemie der Pflanzenschutz- und Schädlingsbekämpfungsmittel [Chemistry of Crop Protection Compositions and Pesticides]," *R. Wegler ed.* 2:401-412, Springer-Verlag, Berlin, Germany (1970).
- English language translation of Draber, W., "Chemie der Pflanzenschutz- und Schädlingsbekämpfungsmittel [Chemistry of Crop Protection Compositions and Pesticides]," *R. Wegler ed.* 2, 15 pages, Springer-Verlag, Berlin, Germany (1970).
- Greene, T. W. and Wuts, P. G. M., "Protection for the Amino Group," in *Protective Groups in Organic Synthesis*, vol. 3, p. 494-653, Third Edition, John Wiley & Sons, Inc., New York, United States (2002).
- Grzyb, J.A., et al., "Carbamoylimidazolium and thiocarbamoylimidazolium salts: novel reagents for the synthesis of ureas, thioureas, carbamates, thiocarbamates and amides," *Tetrahedron* 61:7153-7175, Elsevier Ltd., England (2005).
- Grzyb, J.A. and Batey, R.A., "Achieving functional group diversity in parallel synthesis: solution-phase synthesis of a library of ureas, carbamates, thiocarbamates, and amides using carbamoylimidazolium salts," *Tetrahedron Letters*, 49:5279-5282, Elsevier Ltd., England (2008).
- Haberman, J.M. and Gin, D.Y., "Dehydrative Sialylation with C2-Hemiketal Sialyl Donors," *Organic Letters* 5(14):2539-2541, American Chemical Society, United States (2003).
- Kanemasa, S., et al., "Synthesis of Hydroximoyl Chlorides from Aldoximes and Benzyltrimethylammonium Tetrachloroiodate (BTMA ICl₄)," *Tetrahedron* 56:1057-1064, Elsevier Science Ltd, England (2000).
- Lee, G.A., "A Simplified Synthesis of Unsaturated Nitrogen-Heterocycles using Nitrile Betaines," *Synthesis*, 6:508-509, Thieme Stuttgart, Germany (1982).
- Metzger, J.V., "Thiazoles and their Benzo Derivatives," in *Comprehensive Heterocyclic Chemistry*, vol. 6, pp. 235-363, Pergamon Press, England (1984).
- Montalbetti, C.A.G.N. and Falque, V., "Amide bond formation and peptide coupling," *Tetrahedron* 61:10827-10852, Elsevier Ltd., England (2005).
- Pasternak, A., et al., "Potent heteroaryl-piperidine and carboxyphenyl-piperidine 1-alkyl-cyclopentane carboxamide CCR2 antagonists," *Bioorganic & Medicinal Chemistry Letters* 18:994-998, Elsevier Ltd., England (2008).
- Porcelli, R.V. and Juran, B., "Selecting the process for your next MMA plant," *Hydrocarbon Processing* 65:37-43, Gulf Pub. Co, United States (1986).
- Prikryl, J., et al., "Stable Triazenes Derived from 2-Alkylaminonaphthalenes and 5-Nitrobenzo[c]-1,2-thiazole-3-diazonium Hydrogensulfate," *Eur. J. Org. Chem.* 19:3272-3278, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany (2008).
- Qiao, J.X., et al., "Highly efficacious factor Xa inhibitors containing α -substituted phenylcycloalkyl P4 moieties," *Bioorganic & Medicinal Chemistry Letters* 19(2):462-468, Elsevier Ltd., England (2008).
- Rouden, J., et al., "Studies toward Labeling Cytisine with [¹¹C]Phosgene: Rapid Synthesis of a δ -Lactam Involving a New Chemoselective Lithiation-Annulation Method," *J. Org. Chem.* 69(11):3787-3793, American Chemical Society, United States (2004).
- Schweifer, A. and Hammerschmidt, F., "Formal and improved synthesis of enantiopure chiral methanol," *Tetrahedron* 64:7605-7610, Elsevier Ltd., England (2008).
- Shakespeare, W.C. et al., "SAR of Carbon-Linked, 2-Substituted Purines: Synthesis and Characterization of AP23451 as a novel Bone-Targeted Inhibitor of Src Tyrosine Kinase With In Vivo Anti-Resorptive Activity," *Chem Biol Drug Design* 71:97-105, Blackwell Munksgaard, England (2008).
- Thomsen, I., et al., "Thiation With 2,4-Bis(4-Methoxyphenyl)-1,3,2,4-Dithiadiphosphetane 2,4-Disulfide: N-Methylthiopyrrolidone," *Organic Syntheses, Coll.* 7:372, Organic Syntheses, Inc., United States (1990).
- Wardell, J.L., "Preparation of thiols," in *The Chemistry of the Thiol Group*, vol. 1, pp. 163-269, Patai, S., eds., John Wiley & Sons Ltd., Chichester, UK (1974).
- Zificsak, C.A. and Hlasta, D.J., "Current methods for the synthesis of 2-substituted azoles," *Tetrahedron* 60:8991-9016, Elsevier Ltd., England (2004).
- English language Abstract of Japanese Patent Publication No. JP 60-156601 A, European Patent Office, espacenet database—Worldwide (1985).
- English language Abstract of German Patent Publication No. DE 10 2010 000 662 A1, European Patent Office, espacenet database—Worldwide (2010).
- English language Abstract of International Patent Publication No. WO 2012/055837A1, European Patent Office, espacenet database—Worldwide (2010).
- International Search Report for International Application No. PCT/EP2012/051499, European Patent Office, The Hague, Netherlands, mailed on Apr. 24, 2012.
- Office action mailed Oct. 9, 2013 in U.S. Appl. No. 13/206,223, inventors Tsuchiya et al., filed Aug. 9, 2011.
- Office action mailed Oct. 9, 2013 in U.S. Appl. No. 13/096,637, inventors Cristau et al., filed Apr. 28, 2011.
- Office action mailed Jul. 25, 2013 in U.S. Appl. No. 13/216,033, inventors Tsuchiya et al., filed Aug. 23, 2011.
- Patani, G.A., and Lavoie, E.J., "Bioisosterism: A Rational Approach in Drug Design," *Chem. Rev.* 96:3147-3176, American Chemical Society, United States (1996).
- Rubini, E., et al., "Synthesis of Isosteric Methylene-oxy Pseudodipeptide Analogues as Novel Amide Bond Surrogate Units,"

(56)

References Cited

OTHER PUBLICATIONS

Tetrahedron 42(21):6039-6045, Pergamon Journals Ltd, England (1986).

"Sugary extender," from list of sweetcorn varieties, Wikipedia.com, accessed at http://en.wikipedia.org/wiki/List_of_sweetcom_varieties, accessed on May 20, 2014, 10 pages.

"Extender for TagTeam/Cell-Tech liquid soybean," Material Safety Data Sheet, Novozymes, Canada (2011).

Office action mailed Mar. 7, 2014 in U.S. Appl. No. 13/206,223, inventors Tsuchiya et al., filed Aug. 9, 2011.

Office Action mailed Mar. 5, 2013 in U.S. Appl. No. 13/096,637, inventors Cristau et al., filed Apr. 28, 2011.

Advisory Action mailed Mar. 6, 2014, in U.S. Appl. No. 13/096,637, Cristau, P., et al., filed Apr. 28, 2011.

Office Action mailed Dec. 15, 2014, in U.S. Appl. No. 13/096,637, Cristau, P., et al., filed Apr. 28, 2011.

* cited by examiner

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HETEROARYLPIPERIDINE AND- PIPERAZINE DERIVATES AS FUNGICIDES

This application is a division of U.S. application Ser. No. 13/364,168, filed Feb. 1, 2012, which claims the benefit to U.S. Provisional Application No. 61/438,374, filed on Feb. 1, 2011 and EP 11152839.4, filed on Feb. 1, 2011, all of which are entirely incorporated by reference herein.

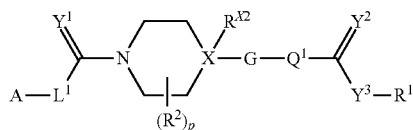
The invention relates to heteroaryl piperidine and -piperazine derivatives, to agrochemically active salts thereof, to use thereof and to methods and compositions for controlling phytopathogenic harmful fungi in and/or on plants or in and/or on seed of plants, to processes for producing such compositions and treated seed, and to use thereof for controlling phytopathogenic harmful fungi in agriculture, horticulture and forestry, in animal health, in the protection of materials and in the domestic and hygiene sector. The present invention further relates to a process for preparing heteroaryl piperidine and -piperazine derivatives.

It is known that particular heterocyclically substituted thiazoles can be used as fungicidal crop protection agents (see patent applications with publication numbers: WO 07/014290, WO 08/013925, WO 08/013622, WO 08/091594, WO 08/091580, WO 09/055514, WO 09/094407, WO 09/094,445, WO 09/132785, WO 10/037479, WO10/065579, WO2010/066353, see also patent applications with application numbers: DE102010000662.9, PCT/EP2010/003499, EP09174510.9, EP09174614.9; EP09180073.0, EP10161264.6, EP10163067.1, EP10164099.3, EP10172486.2, EP10174012.4, EP 10189067.1).

Since the ecological and economic demands made on modern crop protection compositions are increasing constantly, for example with respect to activity spectrum, toxicity, selectivity, application rate, formation of residues and favourable manufacture, and there can also be problems, for example, with resistances, it is a constant objective to develop novel crop protection compositions, especially fungicides, which have advantages over the known compositions at least in some areas.

It has now been found that, surprisingly, the present heteroaryl piperidine and -piperazine derivatives achieve at least some aspects of the objects mentioned and are suitable for use as crop protection compositions, especially as fungicides.

The invention provides compounds of the formula (I)



in which the radicals are each defined as follows:

A is phenyl which is bonded to L¹ and may otherwise contain up to five further substituents, where the substituents are each independently selected from Z⁴⁻¹,

or

A is an optionally benzofused, unsubstituted or substituted 5- or 6-membered heteroaryl which is bonded to L¹ and may otherwise contain up to four further substituents, where the substituents on carbon are each independently selected from Z⁴⁻² and the substituents on nitrogen are each independently selected from Z⁴⁻³,

Z⁴⁻¹ are the same or different and are each independently hydrogen, halogen, hydroxyl, thioxy, nitro, cyano,

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—C(=O)H, —C(=O)OH, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, cycloalkenyl, halocycloalkyl, halocycloalkenyl, hydroxyalkyl, cyanoalkyl, formylalkyl, alkoxyalkyl, haloalkoxyalkyl, cycloalkoxyalkyl, alkynyloxyalkyl, alkylthioalkyl, alkylsulphinyllalkyl, alkylaminoalkyl, haloalkylaminoalkyl, cycloalkylaminoalkyl, dialkylaminoalkyl, alkylcarbonylalkyl, alkylsulphonyllalkyl, alkylcycloalkyl, alkylcycloalkenyl, alkoxy, alkylcycloalkylalkyl, halocycloalkoxy, alkylthio, haloalkylthio, cycloalkylthio, alkynylthio, alkenyloxy, alkynyloxy, haloalkoxy, haloalkenyloxy, haloalkynyloxy, cycloalkoxy, alkoxyalkoxy, cycloalkylalkoxy, alkylcarbonyloxy, haloalkylcarbonyloxy, cycloalkylcarbonyloxy, cycloalkylamino, alkylcarbonylamino, cycloalkylcarbonylamino, alkoxy carbonylamino, alkylsulphonylamino, haloalkylsulphonylamino, phenylsulphonylamino, cycloalkylalkyl, halocycloalkylalkyl, cycloalkylcycloalkyl, alkoxyalkoxyalkyl, alkylaminocarbonyloxy, alkylcarbonylalkoxy, cycloalkylaminocarbonyl, cycloalkylalkoxycarbonyl, alkylsulphonyl, haloalkylsulphonyl, alkylsulphonyl, haloalkylsulphonyl, cycloalkylsulphonyl, alkylcarbonyl, haloalkylsulphonyl, cycloalkylcarbonyl, alkoxy carbonyl, cycloalkoxycarbonyl, trialkylsilyl, —SF₅, phenyl, —C(=O)NR³R⁴ or —NR³R⁴,

Z⁴⁻² and R^{G1} are the same or different and are each independently hydrogen, halogen, hydroxyl, thioxy, nitro, cyano, —C(=O)H, —C(=O)OH, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, hydroxyalkyl, formylalkyl, alkoxyalkyl, alkylcarbonylalkyl, alkylcycloalkyl, alkoxy, alkylcycloalkylalkyl, alkylthio, haloalkylthio, alkynylthio, alkenyloxy, alkynyloxy, haloalkoxy, alkoxyalkoxy, alkylcarbonyloxy, haloalkylcarbonyloxy, cycloalkylcarbonylamino, alkylsulphonylamino, haloalkylsulphonylamino, phenylsulphonylamino, cycloalkylalkyl, halocycloalkylalkyl, cycloalkylcycloalkyl, alkoxy carbonyloxy, alkylcarbonylthio, alkylsulphonyl, haloalkylsulphonyl, alkylsulphonyl, haloalkylsulphonyl, alkylcarbonyl, haloalkylcarbonyl, alkoxy carbonyl, alkylaminocarbonyloxy, —C(=O)NR³R⁴ or —NR³R⁴,

Z⁴⁻³ and R^{G2} are the same or different and are each independently hydrogen, —C(=O)H, —C(=O)NR³R⁴, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, alkoxyalkyl, alkylsulphonyl, haloalkylsulphonyl, cycloalkylsulphonyl, phenylsulphonyl, alkylcarbonyl, haloalkylcarbonyl, alkoxy carbonyl, haloalkoxycarbonyl, cycloalkoxycarbonyl, phenyl or benzyl,

R³, R⁴ and R⁷ are the same or different and are each independently hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, cycloalkyl, benzyl or phenyl,

L¹ is NR^{L12} or C(R^{L11})₂,

R^{L11} is the same or different and is independently hydrogen, halogen, hydroxyl, cyano, —C(=O)H, —C(=O)OH, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, alkoxyalkyl, alkylthioalkyl, alkylaminoalkyl, dialkylaminoalkyl, alkoxy, alkylthio, haloalkylthio, haloalkoxy, alkylcarbonyloxy, alkylcarbonylamino, alkylcarbonylthio, alkylsulphonyl, haloalkylsulphonyl, alkylcarbonyl, haloalkylcarbonyl, alkoxy carbonyl, trialkylsilyloxy, —NR³R⁴ or —C(=O)NR³R⁴,

or the two R^{L11} radicals, together with the carbon atom to which they are bonded, form a cyclopropyl ring, or the two R^{L11} radicals are =CH₂, =COR³, =NOR³ or =CHN(R³)₂,

R^{L12} is hydrogen, —C(=O)H, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, hydroxyalkyl, cyanoalkyl, formylalkyl, alkoxyalkyl, haloalkoxyalkyl, cycloalkoxyalkyl, alkynyloxyalkyl, alkylthioalkyl, alkylsulphinyllalkyl, alkylaminoalkyl, haloalkylaminoalkyl, cycloalkylaminoalkyl, dialkylaminoalkyl, alkoxy, alkylthio, haloalkylthio, haloalkoxy, alkylcarbonyloxy, alkylcarbonylamino, alkylcarbonylthio, alkylsulphonyl, haloalkylsulphonyl, alkylcarbonyl, haloalkylcarbonyl, alkoxy carbonyl, trialkylsilyloxy, —NR³R⁴ or —C(=O)NR³R⁴,

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cloalkyl, alkylcycloalkyl, cycloalkylalkyl, cycloalkylaminocarbonyl, haloalkylaminocarbonyl, alkylsulphonyl, haloalkylsulphonyl, cycloalkylsulphonyl, alkylcarbonyl, haloalkylcarbonyl, alkoxycarbonyl, haloalkoxycarbonyl, cycloalkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, phenyl or benzyl,

Y^1 is sulphur or oxygen,

X is carbon or nitrogen,

R^{x2} and R^8 are the same or different and are each independently hydrogen, alkyl, alkenyl, haloalkyl, alkoxy, halogen, cyano or hydroxyl,

R^2 is oxo, alkyl, alkenyl, haloalkyl, alkoxy, halogen, cyano or hydroxyl,

p is 0, 1 or 2,

G is 5-membered heteroaryl which is substituted by X and Q^1 and may otherwise be unsubstituted or substituted, where the substituents on carbon are each independently selected from R^{G1} and the substituents on nitrogen are each independently selected from R^{G2} ,

Q^1 is saturated or partly or fully unsaturated 5-membered heterocyclyl which is substituted by G and $-C(=Y^2)-Y^3-R^1$ and may otherwise be unsubstituted or substituted, where the substituents are each independently selected from R^{Q1} ,

R^{Q1} is

bonded to carbon of the 5-membered heterocyclyl of Q:

hydrogen, oxo, halogen, cyano, hydroxyl, nitro, $-CHO$, $-C(=O)OH$, $-C(=O)NH_2$, $-C(=O)NR^3R^4$, $-NR^3R^4$, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, cycloalkylcycloalkyl, halocycloalkylalkyl, alkylcycloalkylalkyl, cycloalkenyl, halocycloalkenyl, alkoxyalkyl, haloalkoxyalkyl, cycloalkoxyalkyl, alkoxyalkoxyalkyl, alkylthioalkyl, formylalkyl, alkylcarbonylalkyl, alkylsulphonylalkyl,

alkylsulphonylalkyl, alkylaminoalkyl, dialkylaminoalkyl, haloalkylaminoalkyl, cycloalkylaminoalkyl, alkylcarbonyl, haloalkylcarbonyl, cycloalkylcarbonyl, alkoxycarbonyl, cycloalkoxycarbonyl, cycloalkylalkoxycarbonyl, cycloalkylaminocarbonyl, hydroxyalkyl, alkoxy, haloalkoxy, cycloalkoxy, halocycloalkoxy, cycloalkylalkoxy, alkenyloxy, haloalkenyloxy, alkynyloxy, haloalkynyloxy, alkoxyalkoxy, alkylcarbonyloxy, haloalkylcarbonyloxy, cycloalkylcarbonyloxy, alkylcarbonylalkoxy, alkylthio, haloalkylthio, cycloalkylthio, alkylsulphonyl, haloalkylsulphonyl, alkylsulphonyl, haloalkylsulphonyl, cycloalkylsulphonyl, trialkylsilyl, alkylsulphonylamino, haloalkylsulphonylamino, phenyl or a 5- or 6-membered heteroaryl radical, where the phenyl or the 5- or 6-membered heteroaryl radical may bear up to two further substituents which are each independently selected from: alkenyl, alkenylamino, alkenyloxy, alkenylthio, alkynyl, alkynylamino, alkynyloxy, alkynylthio, alkoxy, alkoxyalkenyl, alkoxyalkynyl, alkoxyalkoxy, alkoxyalkoxyalkyl, alkoxyalkoxyalkoxy, alkoxyalkyl, alkoxyalkylaminocarbonyl, alkoxyalkylcarbonyl, alkoxyamino, alkoxycarbonyl, alkoxyalkoxyalkoxy, alkoxyalkoxyalkyl, alkoxyalkoxyalkoxy, alkoxyhaloalkoxy, alkoxyhaloalkyl, alkyl, alkylamino, alkylaminoalkyl, alkylaminocarbonyl, alkylaminocarbonylalkylamino, alkylaminocarbonylamino, alkylaminosulphonyl, alkylaminothiocarbonyl, alkylaminothiocarbonylamino, alkylcarbonyl, alkylcarbonylalkoxy, alkylcarbonylamino, alkylcarbonyloxy, alkylcarbonylthio, alkylcycloalkyl, alkylcycloalkylalkyl, alkylsulphonyl, alkylsulphonylalkyl, alkylsulphonyl, alkylsul-

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phenylalkyl, alkylsulphonylamino, alkylsulphonylaminocarbonyl, alkylthio, alkylthioalkyl, alkylthiocarbonyl, alkylthiocarbonyloxy, amino, aminocarbonyl, $C(=N-OR^7)R^8$, $C(=O)H$, $C(=O)OH$, cyano, cyanoalkoxy, cyanoalkyl, cycloalkenyl, cycloalkenyloxyalkyl, cycloalkoxy, cycloalkoxyalkyl, cycloalkoxycarbonyl, cycloalkyl, cycloalkylalkoxy, cycloalkylalkoxycarbonyl, cycloalkylalkyl, cycloalkylalkylamino, cycloalkylalkylaminoalkyl, cycloalkylamino, cycloalkylaminoalkyl, cycloalkylaminocarbonyl, cycloalkylcarbonyl, cycloalkylcarbonyloxy, cycloalkylcycloalkyl, cycloalkylsulphonyl, cycloalkylthio, dialkoxyalkyl, dialkylamino, dialkylaminoalkyl, dialkylaminocarbonyl, dialkylaminocarbonylamino, dialkylaminosulphonyl, dialkylaminothiocarbonyl, dialkylaminothiocarbonylamino, halogen, haloalkenyl, haloalkenyloxy, haloalkynyl, haloalkynyloxy, haloalkoxy, haloalkoxyalkoxy, haloalkoxyalkyl, haloalkoxyamino, haloalkoxycarbonyl, haloalkoxycarbonylamino, haloalkoxyhaloalkoxy, haloalkoxyhaloalkyl, haloalkyl, haloalkylamino, haloalkylaminocarbonyl, haloalkylcarbonyl, haloalkylcarbonylamino, haloalkylcarbonyloxy, haloalkylsulphonyl, haloalkylsulphonyl, haloalkylsulphonylamino, haloalkylsulphonylaminocarbonyl, haloalkylthio, halocycloalkenyl, halocycloalkenyloxyalkyl, halocycloalkoxy, halocycloalkoxyalkyl, halocycloalkyl, halocycloalkylalkyl, halocycloalkylcarbonyloxy, halodialkylamino, halodialkylaminoalkyl, hydroxyl, hydroxyalkyl, $NHCHO$, $NHCN$, nitro, phenylsulphonylamino, SH , SF_5 , SO_2NHCN , thioxy, trialkylsilyl, hydrogen;

bonded to nitrogen of the 5-membered heterocyclyl of Q: hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, phenyl, benzyl, alkylsulphonyl, phenylsulphonyl, $-C(=O)H$, alkoxycarbonyl, benzyloxyalkyl, alkylcarbonylalkyl or alkylcarbonyl,

Y^2 is oxygen or sulphur,

Y^3 is oxygen, sulphur or $-(NR^{13})-$,

R^{13} is hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, cycloalkylalkyl, halocycloalkyl, benzyl, phenyl, NR^3R^4 , alkylcarbonyl, alkylalkoxy, alkylaminocarbonyl, trialkylsilyl, benzyloxyalkyl, alkoxy, haloalkoxy, phenoxy or benzyloxy,

R^1 is substituted C_1 - C_5 -alkyl,

where the substituents are each independently selected from $-Q^2$ and/or Z^{1a} ,

or

R^1 is unsubstituted or substituted C_6 - C_{10} -alkyl,

where the substituents are each independently selected from $-Q^2$ and/or Z^{1b} when $Y^3=O$, S, $-NH-$,

or

R^1 is substituted C_6 - C_{10} -alkyl,

where the substituents are each independently selected from Q^2 and/or Z^{1b} when $Y^3=-(NR^{13})-$ and $R^{13}\neq H$,

or

R^1 is unsubstituted C_6 - C_{10} -alkyl when $Y^2=S$ and $Y^3=-(NR^{13})-$ and $R^{13}\neq H$,

or

R^1 is unsubstituted C_8 - C_{11} -alkyl

when $Y^3=-(NR^{13})-$ and $R^{13}\neq H$ and $Y^2\neq S$,

or

R^1 is unsubstituted or substituted C_2 - C_6 -alkenyl or C_2 - C_6 -alkynyl,

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where the substituents are each independently selected from $-Q^2$ and/or Z^{1e} ,

or

R^1 is substituted C_3 - C_7 -cycloalkyl,

where the substituents are each independently selected from $-Q^2$, Z^{1d} , oxo and/or thioxo,

or

R^1 is substituted C_3 - C_7 -cycloalkyl- C_1 - C_3 -alkyl,

where the substituents are each independently selected from $-Q^2$, Z^{1d} , oxo and/or thioxo,

or

R^1 is unsubstituted C_3 - C_7 -cycloalkyl- C_1 - C_3 -alkyl when Y^3 is NR^{13} ,

or

R^1 is unsubstituted or substituted C_5 - C_{10} -cycloalkenyl or C_5 - C_{10} -cycloalkenyl- C_1 - C_4 -alkyl,

where the substituents are each independently selected from $-Q^2$, Z^{1e} , oxo and/or thioxo,

or

R^1 is unsubstituted or substituted phenyl, benzyl or naphthalenyl,

where the substituents are each independently selected from $-L^2Q^2$ and/or Z^{1f} ,

or

R^1 represents saturated or partly or fully unsaturated, unsubstituted or substituted, bi- or tricyclic 8- to 11-membered carbocyclic or heterocyclic ring systems,

where the substituents are each independently selected from Z^{1g} , oxo and/or thioxo,

or

R^1 is an unsubstituted or substituted, optionally 5- or 6-membered heteroaryl radical,

where the substituents on carbon are each independently selected from $-L^2Q^2$ and/or Z^{1h} , and the substituents on nitrogen are each independently selected from Z^{1i} ,

or

R^1 is a benzofused unsubstituted or substituted 5- or 6-membered heteroaryl radical,

where the substituents on carbon are each independently selected from Z^{1j} , and the substituents on nitrogen are each independently selected from Z^{1k} ,

or

R^1 is unsubstituted or substituted 5-, 6- or 7-membered, non-aromatic (saturated or partly unsaturated) heterocycl systems,

where the substituents on carbon are each independently selected from Z^{1l} , oxo and/or thioxo, and the substituents on nitrogen are each independently selected from Z^{1m} ,

or

R^1 forms with R^{13} , when Y^3 is $-(NR^{13})-$, together with the nitrogen atom through which they are bonded, a 5 to 15-membered, unsubstituted or substituted, saturated or partly saturated or unsaturated mono-, bi- or tricyclic ring system which may contain up to two further heteroatoms selected from N, O and S, where no two oxygen atoms are adjacent and where possible substituents on carbon are each independently selected from R^{10} , oxo and/or thioxo, and where possible substituents on nitrogen are each independently selected from R^{11} ,

or

R^1 is unsubstituted C_1 - C_5 -alkyl, unsubstituted C_3 - C_7 -cycloalkyl or unsubstituted C_3 - C_7 -cycloalkyl C_1 - C_6 -alkyl when Y^3 is sulphur and/or Y^2 is sulphur,

Q^2 is a phenyl ring which bears up to two substituents each independently selected from Z^{1f}

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or

Q^2 is a 5- or 6-membered heteroaryl radical which may contain up to two substituents, where the substituents are each independently selected from the following list:

substituents on carbon: hydrogen, halogen, cyano, hydroxyl, formyl, SH, nitro, NR^6R^7 , alkyl, alkenyl, alkenyloxy, alkynyl, alkynyloxy, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, cycloalkylcycloalkyl, alkylcycloalkylalkyl, alkoxyalkyl, alkylcarbonyl, alkoxy carbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, hydroxyalkyl, alkoxy, haloalkoxy, alkylcarbonyloxy, alkylcarbonylthio, alkylthio, haloalkylthio, alkylsulphinyl, haloalkylsulphinyl, alkylsulphonyl, haloalkylsulphonyl, trialkylsilyl or phenyl,

substituents on nitrogen: hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, phenyl, benzyl, alkylsulphonyl, phenylsulphonyl, $C(=O)H$, alkoxy carbonyl, benzyloxy carbonyl, alkylaminocarbonyl, alkylcarbonylalkyl or alkylcarbonyl,

R^6 and R^9 are the same or different and are each independently hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, cycloalkyl, benzyl, phenyl, alkylsulphonyl, phenylsulphonyl, alkoxy carbonyl, haloalkoxy carbonyl, benzyloxy carbonyl, alkylaminocarbonyl, alkylcarbonylalkyl, alkylcarbonyl, haloalkylcarbonyl or trialkylsilyl,

L^2 is a direct bond, $-O-$, $-C(=O)-$, $-S(O)_m-$, $-CHR^8$ or NR^9- , $-(C=O)O-$, $-(C=O)NR^3-$, $-O(C=O)-$ or $-NR^3(C=O)-$

m is 0, 1 or 2,

Z^{1a} is cyano, halogen, nitro, formyl, NR^6R^7 , haloalkyl, cycloalkylcycloalkyl, alkenyl, haloalkenyl, alkynyl, haloalkynyl, trialkylsilyl, phenyl, hydroxyl, SH, oxo, alkoxy, alkoxyalkoxy, haloalkoxy, alkenyloxy, alkynyloxy, cycloalkyloxy, cycloalkylalkyloxy, halocycloalkyloxy, halocycloalkylalkyloxy, alkoxy carbonyl, alkylcarbonyloxy, alkylcarbonyl, alkylthio or haloalkylthio, phenoxy,

Z^{1b} , Z^{1c} , Z^{1d} , Z^{1e} , Z^{1g} are the same or different and are each independently cyano, halogen, nitro, NR^6R^7 , alkyl, haloalkyl, cycloalkyl, cycloalkylcycloalkyl, alkenyl, haloalkenyl, alkynyl, haloalkynyl, trialkylsilyl, phenyl, hydroxyl, SH, oxo, alkoxy, alkoxyalkoxy, haloalkoxy, alkenyloxy, alkynyloxy, cycloalkyloxy, cycloalkylalkyloxy, halocycloalkyloxy, halocycloalkylalkyloxy, alkoxy carbonyl, alkylcarbonyloxy, alkylcarbonyl, alkylthio or haloalkylthio, phenoxy,

Z^{1f} is hydrogen, alkenyl, alkenylamino, alkenyloxy, alkenylthio, alkynyl, alkynylamino, alkynyloxy, alkynylthio, alkoxy, alkoxyalkenyl, alkoxyalkynyl, alkoxyalkoxy, alkoxyalkoxyalkyl, alkoxyalkoxy carbonyl, alkoxyalkyl, alkoxyalkylaminocarbonyl, alkoxyalkylcarbonyl,

alkoxyamino, alkoxy carbonyl, alkoxy carbonylalkoxy, alkoxy carbonylalkyl, alkoxy carbonylamino, alkoxy haloalkoxy, alkoxy haloalkyl, alkyl, alkylamino, alkylaminocarbonyl, alkylaminocarbonylalkyl, alkylaminocarbonylamino, alkylaminosulphonyl, alkylaminothiocarbonyl, alkylaminothiocarbonylamino, alkylcarbonyl, alkylcarbonylalkoxy, alkylcarbonylamino, alkylcarbonyloxy, alkylcarbonylthio, alkylcycloalkyl, alkylcycloalkylalkyl, alkylsulphinyl, alkylsulphinylalkyl, alkylsulphonyl, alkylsulphonylalkyl, alkylsulphonylamino, alkylsulphonylaminocarbonyl, alkylthio, alkylthioalkyl, alkylthiocarbonyl, alkylthiocarbonyloxy, amino, aminocarbonyl, $C(=N-OR^7)R^8$, $C(=O)H$, $C(=O)NHCN$, $C(=O)OH$, cyano, cyanoalkoxy, cyanoalkyl, cycloalkenyl, cycloalkenyloxyalkyl, cycloalkoxy, cycloalkoxyalkyl, cycloalkoxy carbonyl, cycloalkyl,

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cycloalkylalkoxy, cycloalkylalkoxycarbonyl, cycloalkylalkyl, cycloalkylalkylamino, cycloalkylalkylaminoalkyl, cycloalkylamino, cycloalkylaminoalkyl, cycloalkylaminocarbonyl, cycloalkylcarbonyl, cycloalkylcarbonyloxy, cycloalkylcycloalkyl, cycloalkylsulphonyl, cycloalkylthio, dialkoxyalkyl, dialkylamino, dialkylaminoalkyl, dialkylaminocarbonyl, dialkylaminocarbonylamino, dialkylaminosulphonyl, dialkylaminothiocarbonyl, dialkylaminothiocarbonylamino, halogen, haloalkenyl, haloalkenyloxy, haloalkynyl, haloalkynyloxy, haloalkoxy, haloalkoxyalkoxy, haloalkoxyalkyl, haloalkoxyamino, haloalkoxycarbonyl, haloalkoxycarbonylamino, haloalkoxyhaloalkoxy, haloalkoxyhaloalkyl, haloalkyl, haloalkylamino, haloalkylaminoalkyl, haloalkylcarbonyl, haloalkylcarbonylamino, haloalkylcarbonyloxy, haloalkylsulphanyl, haloalkylsulphonyl, haloalkylsulphonylamino, haloalkylsulphonylaminoalkyl, haloalkylthio, halocycloalkenyl, halocycloalkenyloxyalkyl, halocycloalkoxy, halocycloalkoxyalkyl, halocycloalkyl, halocycloalkylalkyl, halocycloalkylcarbonyloxy, halodialkylamino, halodialkylaminoalkyl, hydroxyl, hydroxyalkyl, NHCHO, NHCN, nitro, phenylsulphonylamino, SH, SF₅, SO₂NHCN, thioxy, trialkylsilyl,

Z^{1h}, Z^{1j} and Z¹ⁱ are the same or different and are each independently hydrogen, oxo, halogen, cyano, hydroxyl, nitro, —CHO, —C(=O)OH, —C(=O)NH₂, —C(=O)NR³R⁴, —NR³R⁴, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, cycloalkylcycloalkyl, halocycloalkylalkyl, alkylcycloalkylalkyl, cycloalkenyl, halocycloalkenyl, alkoxyalkyl, haloalkoxyalkyl, cycloalkoxyalkyl, alkoxyalkoxyalkyl, alkylthioalkyl, formylalkyl, alkylcarbonylalkyl, alkylsulphanylalkyl, alkylsulphonylalkyl, alkylaminoalkyl, dialkylaminoalkyl, haloalkylaminoalkyl, cycloalkylaminoalkyl, alkylcarbonyl, haloalkylcarbonyl, cycloalkylcarbonyl, alkoxyalkoxy, cycloalkoxyalkoxy, cycloalkylalkoxy, alkenyloxy, haloalkenyloxy, alkynyloxy, haloalkynyloxy, alkoxyalkoxy, alkylcarbonyloxy, haloalkylcarbonyloxy, cycloalkylcarbonyloxy, alkylcarbonylalkoxy, alkylthio, haloalkylthio, cycloalkylthio, alkylsulphanyl, haloalkylsulphanyl, alkylsulphonyl, haloalkylsulphonyl, cycloalkylsulphonyl, trialkylsilyl, alkylsulphonylamino, haloalkylsulphonylamino,

Z¹ⁱ, Z^{1k} and Z^{1m} are the same or different and are each independently hydrogen, alkyl, alkenyl, alkynyl, haloalkyl, haloalkenyl, haloalkynyl, cycloalkyl, halocycloalkyl, alkylcycloalkyl, cycloalkylalkyl, phenyl, benzyl, alkylsulphonyl, —C(=O)H, alkoxyalkoxy, benzyloxyalkoxy or alkylcarbonyl,

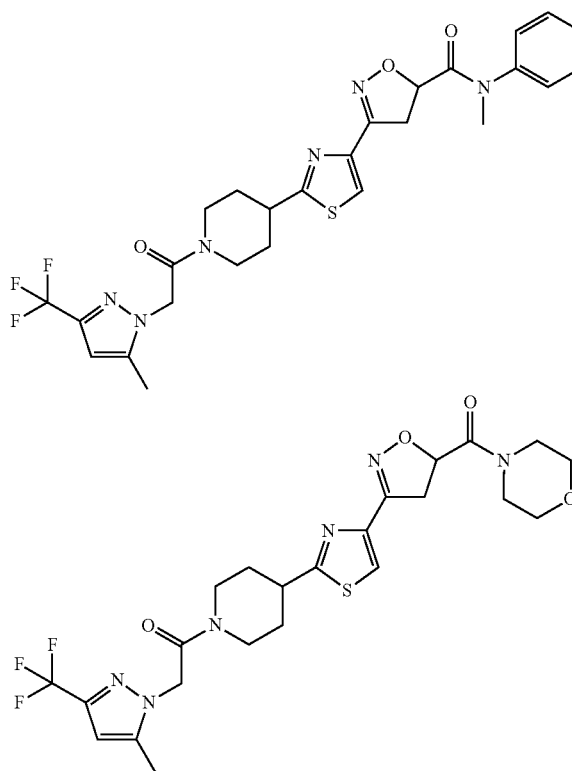
R¹⁰ is hydrogen, cyano, halogen, NR⁶R⁷, alkyl, haloalkyl, cycloalkyl, alkenyl, haloalkenyl, alkynyl, haloalkynyl, trialkylsilyl, phenyl, hydroxyl, oxo, alkoxy, haloalkoxy, alkenyloxy, alkynyloxy, alkylthio or haloalkylthio,

R¹¹ is hydrogen, alkyl, haloalkyl, cycloalkyl, alkenyl, haloalkenyl, alkynyl, haloalkynyl, trialkylsilyl, benzyl, phenyl, alkylsulphonyl, phenylsulphonyl, C(=O)H, alkoxyalkoxy, haloalkoxyalkoxy, benzyloxyalkoxy, alkylaminocarbonyl, alkylcarbonylalkyl, alkylcarbonyl or haloalkylcarbonyl

and salts, metal complexes and N-oxides of the compounds of the formula (I).

The compounds of the formula (I) exclude the following compounds:

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The compounds excluded from the compounds of the formula (I) are disclosed in WO2008013925 (p. 261 and p. 264) and WO2008013622 (p. 259 and p. 262).

The invention further provides for the use of the compounds of the formula (I) as fungicides.

Inventive heteroaryl piperidine and -piperazine derivatives of the formula (I) and the salts, metal complexes and N-oxides thereof are very suitable for controlling phytopathogenic harmful fungi. The aforementioned inventive compounds exhibit, in particular, potent fungicidal activity and can be used in crop protection, in the domestic and hygiene sector and in the protection of materials.

The compounds of the formula (I) may be present either in pure form or as mixtures of different possible isomeric forms, especially of stereoisomers, such as E and Z, threo and erythro, and also optical isomers, such as R and S isomers or atropisomers, and, if appropriate, also of tautomers. Both the E and Z isomers, and the threo and erythro isomers, and also the optical isomers, any desired mixtures of these isomers, and the possible tautomeric forms are claimed.

The radical definitions of the inventive compounds of the formula (I) have the following preferred, more preferred and most preferred definitions:

A is preferably phenyl which is bonded to L¹ and may otherwise contain up to two substituents, where the substituents are each independently selected from the following list:

halogen, cyano, hydroxyl, —NR³R⁴, —C(=O)NR³R⁴, nitro, C₁-C₆-alkyl, C₂-C₆-alkenyl, C₂-C₆-alkynyl, C₃-C₈-cycloalkyl, C₁-C₆-haloalkyl, C₂-C₆-haloalkenyl, C₂-C₆-haloalkynyl, C₃-C₆-halocycloalkyl, C₁-C₄-alkoxy, C₁-C₄-haloalkoxy, C₁-C₄-alkenyloxy, C₁-C₄-alkynyloxy, C₁-C₄-alkylthio, C₁-C₄-alkylsulphonyl, C₁-C₄-haloalkylthio, C₁-C₄-haloalkylsulphonyl, C₁-C₄-alkoxy-C₁-C₆-alkyl, hydroxyl-C₁-C₄-alkyl,

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C₁-C₆-alkylcarbonyl, C₁-C₆-alkoxycarbonyl, C₁-C₆-alkylcarbonyloxy or —C(=O)H, or,

A is preferably a heteroaromatic radical selected from the following group: furan-2-yl, furan-3-yl, thiophen-2-yl, thiophen-3-yl, isoxazol-3-yl, isoxazol-4-yl, isoxazol-5-yl, pyrrol-1-yl, pyrrol-2-yl, pyrrol-3-yl, oxazol-2-yl, oxazol-4-yl, oxazol-5-yl, thiazol-2-yl, thiazol-4-yl, thiazol-5-yl, isothiazol-3-yl, isothiazol-4-yl, isothiazol-5-yl, pyrazol-1-yl, pyrazol-3-yl, pyrazol-4-yl, imidazol-1-yl, imidazol-2-yl, imidazol-4-yl, 1,2,3-triazol-1-yl, 1,2,4-triazol-1-yl, pyridin-2-yl, pyridin-3-yl, pyridin-4-yl, pyridazin-3-yl, pyridazin-4-yl, pyrazin-2-yl, pyrazin-3-yl, pyrimidin-2-yl, pyrimidin-4-yl or pyrimidin-5-yl, which is bonded to L¹ and which may otherwise contain up to two substituents, where the substituents are each independently selected from the following list:

substituents on carbon:

halogen, cyano, hydroxyl, nitro, —NR³R⁴, C₁-C₆-alkyl, C₂-C₆-alkenyl, C₂-C₆-alkynyl, C₃-C₆-cycloalkyl, C₁-C₆-haloalkyl, C₂-C₆-haloalkenyl, C₂-C₆-haloalkynyl, C₃-C₆-halocycloalkyl, C₁-C₄-alkoxy, C₁-C₄-haloalkoxy, C₁-C₄-alkylthio, C₁-C₄-alkylsulphonyl, C₁-C₄-haloalkylthio, C₁-C₄-haloalkylsulphonyl, C₁-C₄-alkoxy-C₁-C₄-alkyl, hydroxy-C₁-C₄-alkyl, C₁-C₆-alkylcarbonyl, C₁-C₆-alkoxycarbonyl, C₁-C₆-alkylcarbonyloxy or phenyl,

substituents on nitrogen:

C₁-C₆-alkyl, C₂-C₆-alkenyl, C₂-C₆-alkynyl, C₁-C₆-haloalkyl, C₂-C₆-haloalkenyl, C₂-C₆-haloalkynyl, C₃-C₁₀-cycloalkyl-C₁-C₆-alkyl, C₁-C₆-haloalkylcarbonyl, phenyl, benzyl, C₁-C₄-alkylsulphonyl, C₁-C₄-haloalkylsulphonyl, phenylsulphonyl, —C(=O)H, or C₁-C₆-alkylcarbonyl,

A is more preferably phenyl which is bonded to L¹ and may otherwise contain up to two further substituents, where the substituents are each independently selected from the following list:

fluorine, bromine, iodine, chlorine, cyano, nitro, methyl, ethyl, n-propyl, 1-methylethyl, 1,1-dimethylethyl, chlorofluoromethyl, dichloromethyl, dichlorofluoromethyl, difluoromethyl, trichloromethyl, trifluoromethyl, cyclopropyl, ethoxy, 1-methylethoxy, n-propoxy, methoxy, trifluoromethoxy, difluoromethoxy, 1-methylethylthio, methylthio, ethylthio, n-propylthio, difluoromethylthio or trifluoromethylthio, or

A is more preferably a heteroaromatic radical selected from the following group: furan-2-yl, furan-3-yl, thiophen-2-yl, thiophen-3-yl, isoxazol-3-yl, isoxazol-4-yl, isoxazol-5-yl, pyrrol-1-yl, pyrrol-2-yl, pyrrol-3-yl, oxazol-2-yl, oxazol-4-yl, oxazol-5-yl, thiazol-2-yl, thiazol-4-yl, thiazol-5-yl, isothiazol-3-yl, isothiazol-4-yl, isothiazol-5-yl, pyrazol-1-yl, pyrazol-3-yl, pyrazol-4-yl, imidazol-1-yl, imidazol-2-yl, imidazol-4-yl, 1,2,3-triazol-1-yl, 1,2,4-triazol-1-yl, pyridin-2-yl, pyridin-3-yl, pyridin-4-yl, pyridazin-3-yl, pyridazin-4-yl, pyrimidin-2-yl, pyrimidin-4-yl or pyrimidin-5-yl, which is bonded to L¹ and which may otherwise contain up to two substituents, where the substituents are the same or different and are each independently selected from the following list:

substituents on carbon:

fluorine, chlorine, bromine, iodine, cyano, nitro, methyl, ethyl, n-propyl, 1-methylethyl, 1,1-dimethylethyl, chlorofluoromethyl, dichloromethyl, dichlorofluoromethyl, difluoromethyl, trichloromethyl, trifluoromethyl, cyclopropyl, ethoxy, 1-methylethoxy, n-propoxy, methoxy, trifluoromethoxy, difluoromethoxy, 1-methylethylthio,

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methylthio, ethylthio, n-propylthio, difluoromethylthio, trifluoromethylthio or phenyl,

substituents on nitrogen:

methyl, ethyl, n-propyl, 1-methylethyl, methylsulphonyl, trifluoromethylsulphonyl, methylcarbonyl, trifluoromethylcarbonyl, chloromethylcarbonyl, 2,2-trifluoroethyl, 2,2-difluoroethyl, 2,2-dichloro-2-fluoroethyl, 2-chloro-2-difluoroethyl or 2-chloro-2-fluoroethyl;

or

A is most preferably pyrazol-1-yl which is bonded to L¹ and may otherwise contain up to two substituents, where the substituents are each independently selected from the following list:

methyl, ethyl, chlorine, bromine, fluorine, difluoromethyl or trifluoromethyl, or

A is most preferably phenyl which is bonded to L¹ and may otherwise contain up to two substituents, where the substituents are each independently selected from the following list:

methyl, ethyl, iodine, chlorine, bromine, fluorine, methoxy, ethoxy, difluoromethyl or trifluoromethyl.

R³, R⁴ and R⁷ are preferably the same or different and are each independently hydrogen, C₁-C₆-alkyl, C₂-C₆-alkenyl, C₂-C₆-alkynyl, C₁-C₆-haloalkyl, C₃-C₈-cycloalkyl, benzyl or phenyl, and more preferably hydrogen, methyl, ethyl, n-propyl, 1-methylethyl, n-butyl or 1,1-dimethylethyl,

L¹ is preferably C(R^{L11})₂ (more preferably CHR^{L11}) or NR^{L12} and most preferably CH₂,

R^{L11} is preferably hydrogen, methyl, ethyl or cyclopropyl, or the two R^{L11} radicals, together with the carbon atom to which they are bonded, form a cyclopropyl ring, or the two R^{L11} radicals are =CHN(R³)₂,

R^{L11} is more preferably hydrogen or methyl,

R^{L12} is preferably hydrogen, C₁-C₄-alkyl, C₁-C₄-haloalkyl, C₃-C₈-cycloalkyl, C₁-C₄-alkylsulphonyl, C₁-C₄-alkoxy-carbonyl, and more preferably hydrogen or methyl, and most preferably hydrogen,

Y¹ is preferably oxygen or sulphur and more preferably oxygen,

X is carbon or nitrogen and preferably carbon,

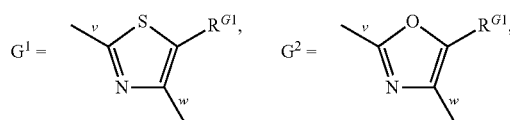
R^{X2} is preferably hydrogen, C₁-C₄-alkyl, C₁-C₄-alkenyl, C₁-C₄-haloalkyl, C₁-C₄-alkoxy, halogen, cyano or hydroxyl, and more preferably hydrogen, fluorine, chlorine, bromine or hydroxyl, and most preferably hydrogen or fluorine,

R⁸ is preferably hydrogen or C₁-C₄-alkyl and more preferably hydrogen and methyl

R² is preferably oxo, C₁-C₄-alkenyl, C₁-C₄-haloalkyl, C₁-C₄-alkoxy, halogen, cyano or hydroxyl, and more preferably fluorine, chlorine, bromine or hydroxyl, and most preferably fluorine,

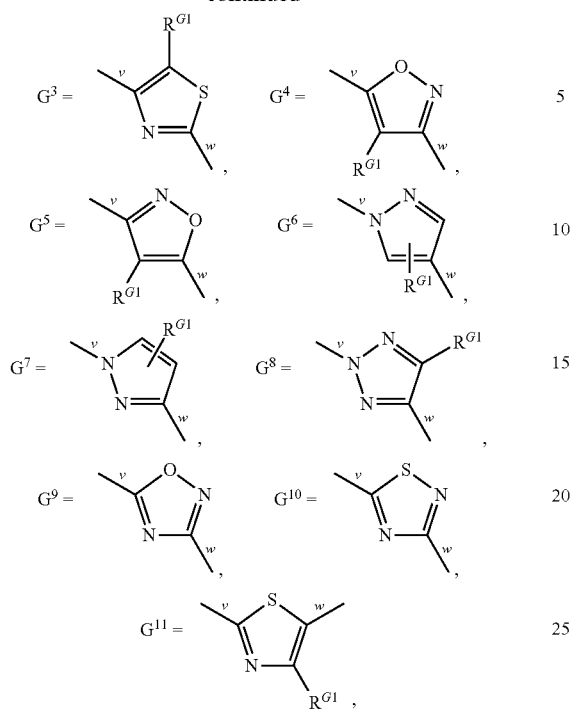
p is preferably 0 to 1, and more preferably 0,

G is preferably



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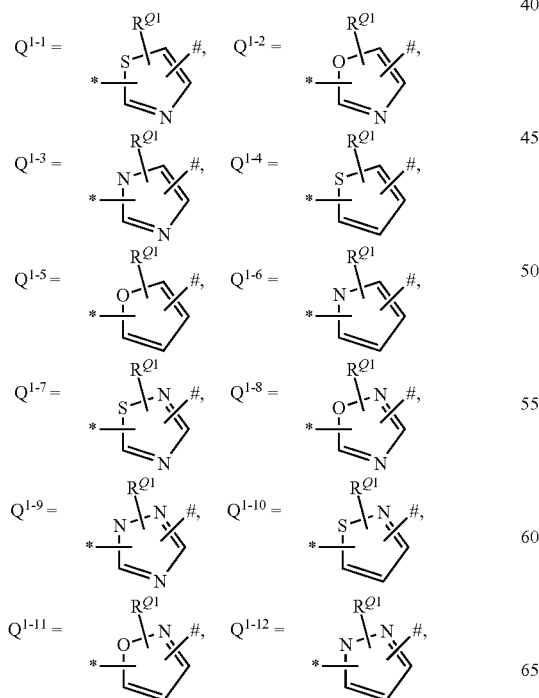
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where the bond identified by "v" is bonded directly to X and where the bond identified by "w" is bonded directly to Q¹,

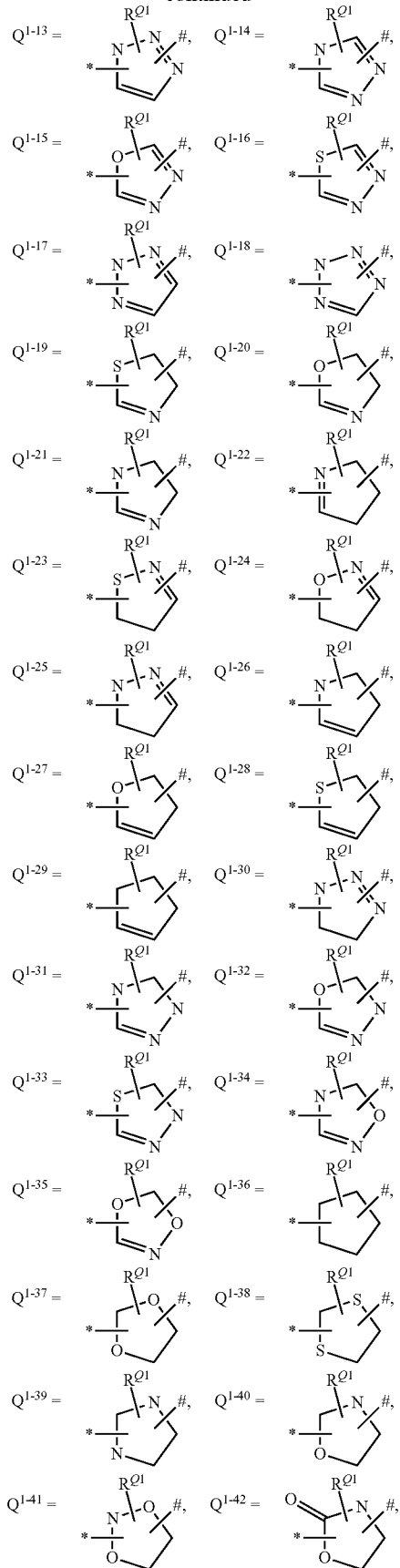
G is more preferably G¹, G² or G³, and most preferably G¹,
R^{G1} is preferably hydrogen or halogen and more preferably hydrogen,

Q¹ is preferably

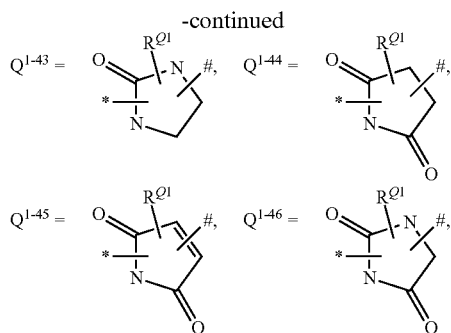


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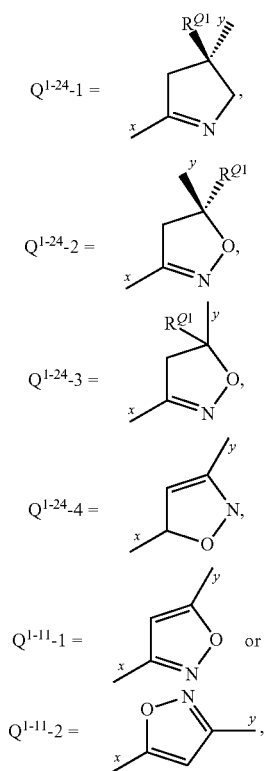
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where the bond identified by “*” is bonded directly to G and, at the same time, the bond identified by “#” is bonded directly to $-C(=Y^2)-Y^3-R^1$, or where the bond identified by “*” is bonded directly to $-C(=Y^2)-Y^3-R^1$ and, at the same time, the bond identified by “#” is bonded directly to G, Q^1 is more preferably



where the bond identified by “x” is bonded directly to G, and where the bond identified by “y” is bonded directly to $-C(=Y^2)-Y^3-R^1$, Q^1 is most preferably Q^{1-24-3} .

R^{Q1} is preferably the same or different and is independently bonded to carbon of the 5-membered heterocycle of Q: hydrogen, cyano, $-NR^3R^4$, C_1-C_6 -alkyl, C_2-C_6 -alkenyl, C_2-C_6 -alkynyl, C_1-C_6 -haloalkyl, C_2-C_6 -haloalkenyl, C_2-C_6 -haloalkynyl, C_3-C_8 -cycloalkyl, C_3-C_8 -halocycloalkyl, C_1-C_4 -alkyl- C_3-C_8 -cycloalkyl, C_3-C_8 -cycloalkyl- C_1-C_4 -alkyl, C_1-C_4 -alkoxy- C_1-C_4 -alkyl, C_3-C_8 -cycloalkoxy- C_1-C_4 -alkyl, C_1-C_4 -alkoxy- C_1-C_4 -alkoxy- C_1-C_4 -alkyl, C_1-C_4 -alkylthio-

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C_1-C_4 -alkyl, C_1-C_6 -alkoxy, C_1-C_6 -haloalkoxy, C_3-C_8 -cycloalkoxy, C_3-C_8 -halocycloalkoxy, C_3-C_8 -cycloalkyl- C_1-C_4 -alkoxy, C_2-C_6 -alkenyl, C_2-C_6 -haloalkenyl, C_2-C_6 -alkynyl, C_1-C_6 -haloalkynyl, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy, C_1-C_6 -alkylcarbonyloxy, C_1-C_6 -haloalkylcarbonyloxy, C_3-C_8 -cycloalkylcarbonyloxy, C_1-C_6 -alkylcarbonyl- C_1-C_6 -alkoxy, C_1-C_6 -alkylthio, C_1-C_6 -haloalkylthio, C_3-C_8 -cycloalkylthio, phenyl or a 5- or 6-membered heteroaryl radical, where the phenyl or the 5- or 6-membered heteroaryl radical bears up to two substituents each independently selected from: C_2-C_6 -alkenyl, C_2-C_6 -alkenylamino, C_2-C_6 -alkenyl, C_2-C_6 -alkenylthio, C_2-C_6 -alkynyl, C_2-C_6 -alkynylamino, C_2-C_6 -alkynylthio, C_1-C_6 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkenyl, C_1-C_6 -alkoxy- C_1-C_4 -alkynyl, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy- C_1-C_4 -alkyl, C_1-C_6 -alkoxy- C_1-C_4 -alkoxycarbonyl, C_1-C_6 -alkoxy- C_1-C_4 -alkyl, C_1-C_6 -alkoxy- C_1-C_4 -alkylaminocarbonyl, C_1-C_6 -alkoxy- C_1-C_4 -alkylcarbonyl, C_1-C_6 -alkoxyamino, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkoxycarbonyl- C_1-C_4 -alkoxy, C_1-C_6 -alkoxycarbonyl- C_1-C_4 -alkyl, C_1-C_6 -alkoxycarbonylamino, C_1-C_6 -alkoxyhalo- C_1-C_4 -alkoxy, C_1-C_6 -alkoxyhalo- C_1-C_4 -alkyl, C_1-C_6 -alkyl, C_1-C_6 -alkylamino, C_1-C_6 -alkylamino- C_1-C_4 -alkyl, C_1-C_6 -alkylaminocarbonyl, C_1-C_6 -alkylaminocarbonyl- C_1-C_4 -alkylamino, C_1-C_6 -alkylaminocarbonylamino, C_1-C_6 -alkylaminosulphonyl, C_1-C_6 -alkylaminothiocarbonyl, C_1-C_6 -alkylaminothiocarbonylamino, C_1-C_6 -alkylcarbonyl, C_1-C_6 -alkylcarbonyl- C_1-C_4 -alkoxy, C_1-C_6 -alkylcarbonylamino, C_1-C_6 -alkylcarbonyloxy, C_1-C_6 -alkylcarbonylthio, C_1-C_6 -alkyl- C_3-C_8 -cycloalkyl, C_1-C_6 -alkyl- C_3-C_8 -cycloalkyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphonyl, C_1-C_6 -alkylsulphonyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphonyl, C_1-C_6 -alkylsulphonyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphonylamino, C_1-C_6 -alkylsulphonylamino- C_1-C_4 -alkyl, C_1-C_6 -alkylthio, C_1-C_6 -alkylthiocarbonyl, C_1-C_6 -alkylthiocarbonyloxy, amino, aminocarbonyl, $C(=N-OR^7)R^8$, $C(=O)NHCN$, $C(=O)OH$, cyano, C_1-C_6 -cyanoalkoxy, C_1-C_6 -cyanoalkyl, C_4-C_8 -cycloalkenyl, C_4-C_8 -cycloalkenyl- C_1-C_4 -alkyl, C_3-C_8 -cycloalkoxy, C_3-C_6 -cycloalkoxy- C_1-C_4 -alkyl, C_3-C_8 -cycloalkoxycarbonyl, C_3-C_8 -cycloalkyl, C_4-C_8 -cycloalkyl- C_1-C_4 -alkoxy, C_4-C_8 -cycloalkyl- C_1-C_6 -alkoxycarbonyl, C_4-C_8 -cycloalkyl- C_1-C_6 -alkyl, C_4-C_8 -cycloalkyl- C_1-C_4 -alkylamino, C_4-C_8 -cycloalkyl- C_1-C_4 -alkylamino- C_1-C_4 -alkyl, C_3-C_8 -cycloalkylamino, C_3-C_8 -cycloalkylamino- C_1-C_4 -alkyl, C_3-C_8 -cycloalkylaminocarbonyl, C_3-C_8 -cycloalkylcarbonyl, C_3-C_8 -cycloalkylcarbonyloxy, C_3-C_6 -cycloalkyl- C_3-C_6 -cycloalkyl, C_3-C_8 -cycloalkylsulphonyl, C_3-C_8 -cycloalkylthio, C_2-C_8 -dialkoxy- C_1-C_4 -alkyl, C_2-C_8 -dialkylamino, C_3-C_8 -dialkylamino- C_1-C_4 -alkyl, C_2-C_8 -dialkylaminocarbonyl, C_2-C_8 -dialkylaminocarbonylamino, C_2-C_8 -dialkylaminosulphonyl, C_2-C_8 -dialkylaminothiocarbonyl, C_2-C_8 -dialkylaminothiocarbonylamino, halogen, C_2-C_8 -haloalkenyl, C_2-C_8 -haloalkenyl, C_2-C_8 -haloalkynyl, C_2-C_8 -haloalkynyl, C_1-C_6 -haloalkoxy, C_2-C_8 -haloalkoxy- C_1-C_4 -alkoxy, C_2-C_8 -haloalkoxy- C_1-C_4 -alkyl, C_1-C_8 -haloalkoxyamino, C_1-C_6 -haloalkoxycarbonyl, C_1-C_6 -haloalkoxycarbonylamino, C_2-C_8 -haloalkoxy- C_1-C_4 -haloalkoxy, C_2-C_8 -haloalkoxy- C_1-C_4 -haloalkyl, C_1-C_6 -haloalkyl, C_1-C_6 -haloalkylamino, C_2-C_8 -haloalkylamino- C_1-C_4 -alkyl, C_1-C_6 -haloalkylcarbonyl,

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C₁-C₆-haloalkylcarbonylamino, C₁-C₆-haloalkylcarbonyloxy, C₁-C₆-haloalkylsulphonyl, C₁-C₆-haloalkylsulphonyl, C₁-C₆-haloalkylsulphonylamino, C₁-C₆-haloalkylsulphonylaminocarbonyl, C₁-C₆-haloalkylthio, C₃-C₈-halocycloalkenyl, C₄-C₈-halocycloalkenyloxy, C₁-C₄-alkyl, C₃-C₈-halocycloalkoxy, C₄-C₈-halocycloalkoxy-C₁-C₄-alkyl, C₃-C₈-halocycloalkyl, C₃-C₆-halocycloalkyl-C₁-C₄-alkyl, C₃-C₈-halocycloalkylcarbonyloxy, C₂-C₈-halodialkylamino, C₃-C₈-halodialkylamino-C₁-C₄-alkyl, hydroxyl, C₁-C₆-hydroxyalkyl, NHCHO, NHCN, nitro, phenylsulphonylamino, SF₅, SO₂NHCN, thioxy, C₃-C₁₂-trialkylsilyl, hydrogen,

bonded to nitrogen of the 5-membered heterocyclyl of Q: hydrogen, —C(=O)H, C₁-C₃-alkyl, C₁-C₆-alkylcarbonyl, C₁-C₆-alkoxycarbonyl or benzyl,

R^{Q1} is more preferably hydrogen, fluorine, cyano, methyl, trifluoromethyl, difluoromethyl or methoxymethyl, or

R^{Q1} is more preferably a phenyl ring which is bonded to a carbon atom of Q¹ and which bears up to two substituents each independently selected from: hydrogen, fluorine, chlorine, nitro, trifluoromethyl, C(=O)H, methyl, ethyl, methoxy, ethoxy, prop-2-yn-1-yloxy, but-2-yn-1-yloxy, pent-2-yn-1-yloxy, but-3-yn-1-yloxy, but-3-en-1-yloxy, 3-chloroprop-2-yn-1-yl oxy, cyanomethoxy, allyloxy, or

R^{Q1} is most preferably hydrogen, or

R^{Q1} is most preferably a phenyl ring bonded to a carbon atom of Q¹,

Y² is preferably oxygen or sulphur and more preferably oxygen,

Y³ is preferably oxygen, sulphur or —(NR^{Y3})— and more preferably oxygen and —(NR^{Y3})—, preferably only oxygen,

R^{Y3} is preferably hydrogen, C₁-C₄-alkyl, C₁-C₄-haloalkyl, C₃-C₆-cycloalkyl, C₁-C₄-alkoxy, and more preferably hydrogen, methyl or cyclopropyl, preferably hydrogen or cyclopropyl,

R¹ is preferably substituted methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, 1,1-dimethylethyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, 1,1-dimethylpropyl, or 1,2-dimethylpropyl, where the substituents are each independently selected from -Q² and/or Z^{1a},

or

R¹ is, when Y²=S and/or Y³=S, preferably methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, 1,1-dimethylethyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethyl-1-methylpropyl and 1-ethyl-2-methylpropyl, cyclopropyl, cyclopentyl, cyclohexyl, cyclopropylmethyl, cyclopropylethyl, cyclopentylmethyl, cyclopentylethyl, cyclohexylmethyl or cyclohexylethyl and preferably methyl, ethyl, propyl, 1-methylethyl, cyclopropyl, cyclopentyl, cyclohexyl, cyclopropylmethyl, cyclopentylmethyl or cyclohexylmethyl,

or

R¹ is preferably substituted or unsubstituted allyl, propargyl, but-2-yn-1-yl, but-3-yn-1-yl, where the substituents are each independently selected from -Q² and/or Z^{1c},

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or

R¹ is preferably substituted cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl and preferably substituted cyclopropyl or cyclohexyl,

where the substituents are each independently selected from -Q², Z^{1d}, oxo and/or thioxo,

or

R¹ is preferably substituted cyclopropylmethyl, cyclobutylmethyl, cyclopentylmethyl, cyclohexylmethyl, cyclopropylethyl, cyclobutylethyl, cyclopentylethyl or cyclohexylethyl and preferably substituted cyclopropylmethyl, cyclopentylmethyl, cyclohexylmethyl,

where the substituents are each independently selected from -Q², Z^{1d}, oxo and/or thioxo,

or

R¹ is, when Y³=—(NR^{Y3})—, preferably cyclopropylmethyl, cyclobutylmethyl, cyclopentylmethyl, cyclohexylmethyl, cyclopropylethyl, cyclobutylethyl, cyclopentylethyl or cyclohexylethyl and preferably cyclopropylmethyl, cyclopentylmethyl or cyclohexylmethyl,

or

R¹ is preferably unsubstituted or substituted cyclopentenyl or cyclohexenyl, preferably unsubstituted cyclopentenyl or cyclohexenyl,

where the substituents are each independently selected from -Q², Z^{1e}, oxo and/or thioxo,

or

R¹ is preferably unsubstituted or substituted cyclopentenylmethyl, cyclohexenylmethyl, cyclopentenylethyl or cyclohexenylethyl and preferably unsubstituted or substituted cyclopentenylmethyl or cyclohexenylmethyl,

where the substituents are each independently selected from -Q², Z^{1e}, oxo and/or thioxo,

or

R¹ is preferably unsubstituted or substituted phenyl or benzyl and preferably substituted phenyl or benzyl,

where the substituents are each independently selected from -L²Q² and/or Z^{1f},

or

R¹ is preferably unsubstituted or substituted furan-2-yl, furan-3-yl, thiophen-2-yl, thiophen-3-yl, isoxazol-3-yl, isoxazol-4-yl, isoxazol-5-yl, pyrrol-1-yl, pyrrol-2-yl, pyrrol-3-yl, oxazol-2-yl, oxazol-4-yl, oxazol-5-yl, thiazol-2-yl, thiazol-4-yl, thiazol-5-yl, isothiazol-3-yl, isothiazol-4-yl, isothiazol-5-yl, pyrazol-1-yl, pyrazol-3-yl, pyrazol-4-yl, imidazol-1-yl, imidazol-2-yl, imidazol-4-yl, 1,2,4-oxadiazol-3-yl, 1,2,4-oxadiazol-5-yl, 1,3,4-oxadiazol-2-yl, 1,2,4-thiadiazol-3-yl, 1,2,4-thiadiazol-5-yl, 1,3,4-thiadiazol-2-yl, 1,2,3-triazol-1-yl, 1,2,3-triazol-2-yl, 1,2,3-triazol-4-yl, 1,2,4-triazol-1-yl, 1,2,4-triazol-3-yl, 1,2,4-triazol-4-yl, pyridin-2-yl, pyridin-3-yl, pyridin-4-yl, pyridazin-3-yl, pyridazin-4-yl, pyrimidin-2-yl, pyrimidin-4-yl, pyrimidin-5-yl or pyrazin-2-yl,

where the substituents on carbon are each independently selected from -L²Q² and/or Z^{1h}, and the substituents on nitrogen are each independently selected from Z¹ⁱ,

or

R¹ is preferably unsubstituted or substituted indol-1-yl, indol-2-yl, indol-3-yl, indol-4-yl, indol-5-yl, indol-6-yl, indol-7-yl, benzimidazol-1-yl, benzimidazol-2-yl, benzimidazol-4-yl, benzimidazol-5-yl, indazol-1-yl, indazol-3-yl, indazol-4-yl, indazol-5-yl, indazol-6-yl, indazol-7-yl, indazol-2-yl, 1-benzofuran-2-yl, 1-benzofuran-3-yl, 1-benzofuran-4-yl, 1-benzofuran-5-yl, 1-benzofuran-6-yl, 1-benzofuran-7-yl, 1-benzothiophen-2-yl, 1-benzothiophen-3-yl, 1-benzothiophen-4-yl, 1-benzothiophen-5-yl, 1-benzothiophen-6-yl, 1-benzothiophen-7-yl, 1,3-

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benzothiazol-2-yl, 1,3-benzothiazol-4-yl, 1,3-benzothiazol-5-yl, 1,3-benzothiazol-6-yl, 1,3-benzothiazol-7-yl, 1,3-benzoxazol-2-yl, 1,3-benzoxazol-4-yl, 1,3-benzoxazol-5-yl, 1,3-benzoxazol-6-yl, 1,3-benzoxazol-7-yl, quinolin-2-yl, quinolin-3-yl, quinolin-4-yl, quinolin-5-yl, quinolin-6-yl, quinolin-7-yl, quinolin-8-yl, isoquinolin-1-yl, isoquinolin-3-yl, isoquinolin-4-yl, isoquinolin-5-yl, isoquinolin-6-yl, isoquinolin-7-yl or isoquinolin-8-yl, where the substituents on carbon are each independently selected from Z^{1j} , and the substituents on nitrogen are each independently selected from Z^{1k} ,

or

R^1 is preferably unsubstituted or substituted 1,2,3,4-tetrahydroquinolin-1-yl, 1,2,3,4-tetrahydroisoquinolin-2-yl, 1,2,3,4-tetrahydroquinoxalin-1-yl, indolin-1-yl, isoindolin-2-yl, decahydroquinolin-1-yl or decahydroisoquinolin-2-yl, where the substituents are each independently selected from Z^{1g} , oxo and/or thioxo,

or

R^1 is preferably unsubstituted or substituted piperidin-1-yl, piperidin-2-yl, piperidin-3-yl, piperidin-4-yl, piperazin-1-yl, piperazin-2-yl, piperazin-3-yl, morpholin-1-yl, morpholin-2-yl, morpholin-3-yl, tetrahydropyran-2-yl, tetrahydropyran-3-yl, tetrahydropyran-4-yl, where the substituents on carbon are each independently selected from Z^{1l} , oxo and/or thioxo, and the substituents on nitrogen are each independently selected from Z^{1m} ,

or

R^1 forms with R^{13} , when Y^3 is $-(NR^{13})-$, together with the nitrogen atom through which they are bonded, preferably an unsubstituted or substituted, saturated or partly saturated or unsaturated piperidin-1-yl, piperazin-1-yl, 1,2,3,4-tetrahydroquinolin-1-yl, tetrahydroquinoxalin-1-yl, indolin-1-yl, isoindolin-2-yl, decahydroquinolin-1-yl or decahydroisoquinolin-2-yl, where possible substituents on carbon are each independently selected from R^{10} , oxo and/or thioxo, and where possible substituents on nitrogen are each independently selected from R^{11} .

R^1 is, when $Y^3=S$, more preferably cyclopropyl, cyclopentyl or cyclohexyl,

or

R^1 is more preferably substituted cyclopropyl or cyclohexyl, where the substituents are each independently selected from fluorine, chlorine, bromine, cyano, methyl, ethyl or phenyl,

or

R^1 is more preferably cyclopentenyl or cyclohexenyl,

or

R^1 is more preferably unsubstituted or substituted phenyl or benzyl, where the substituents are each independently selected from fluorine, chlorine, bromine, cyano, methyl, ethyl or methoxy,

Q^2 is preferably a phenyl ring which bears up to two substituents each independently selected from the group of: hydrogen, fluorine, chlorine, nitro, trifluoromethyl, $C(=O)H$, methyl, ethyl, methoxy, ethoxy, prop-2-yn-1-yloxy, but-2-yn-1-yloxy, pent-2-yn-1-yloxy, but-3-yn-1-yloxy, but-3-en-1-yloxy, 3-chloroprop-2-yn-1-yl oxy, cyanomethoxy, allyloxy, or

Q^2 is preferably a 5- or 6-membered heteroaryl radical which may contain up to two substituents, where the substituents are each independently selected from the following list:

substituents on carbon: hydrogen, halogen, cyano, formyl, SH, nitro, NR^6R^7 , C_1-C_6 -alkyl, C_2-C_6 -alkenyl, C_2-C_6 -alkenyloxy, C_2-C_6 -alkynyl, C_2-C_6 -alkynyloxy, C_1-C_6 -

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haloalkyl, C_3-C_6 -cycloalkyl, C_3-C_6 -cycloalkyl- C_1-C_4 -alkyl, C_3-C_6 -cycloalkyl- C_3-C_6 -cycloalkyl, C_1-C_4 -alkoxy- C_1-C_4 -alkyl, C_1-C_4 -alkylcarbonyl, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkylaminocarbonyl, C_2-C_8 -dialkylaminocarbonyl, C_1-C_4 -alkoxy, C_1-C_4 -haloalkoxy, C_1-C_6 -alkylcarbonyloxy or phenyl, preferably hydrogen, fluorine, chlorine, nitro, trifluoromethyl, $C(=O)H$, methyl, ethyl, methoxy, ethoxy, prop-2-yn-1-yloxy, but-2-yn-1-yloxy, pent-2-yn-1-yloxy, but-3-yn-1-yloxy, but-3-en-1-yloxy, 3-chloroprop-2-yn-1-yloxy, cyanomethoxy, allyloxy, substituents on nitrogen: hydrogen, C_1-C_6 -alkyl, C_3-C_6 -cycloalkyl, benzyl, $C(=O)H$, C_2-C_6 -alkoxycarbonyl, benzyloxycarbonyl, C_2-C_6 -alkylaminocarbonyl or C_2-C_6 -alkylcarbonyl, preferably hydrogen, methyl, benzyl, $C(=O)H$, methoxycarbonyl, tert-butoxycarbonyl, benzyloxycarbonyl, methylaminocarbonyl, methylcarbonyl or ethylcarbonyl, or

Q^2 is more preferably a phenyl ring, optionally substituted by up to two substituents, where the substituents are each independently selected from the group of: fluorine, chlorine, methyl, ethyl, trifluoromethyl, methoxy, ethoxy or prop-2-yn-1-yloxy,

Q^2 is most preferably an unsubstituted phenyl ring,

R^6 and R^9 are preferably the same or different and are each independently hydrogen, C_1-C_6 -alkyl, C_2-C_6 -alkenyl, C_2-C_6 -alkynyl, C_1-C_6 -haloalkyl, C_3-C_8 -cycloalkyl, benzyl or phenyl, and more preferably hydrogen, methyl, ethyl, n-propyl, 1-methylethyl, n-butyl or 1,1-dimethylethyl,

L^2 is preferably a direct bond, $-O-$, CHR^8- or $-C(=O)-$, and more preferably a direct bond,

Z^{1a} is preferably cyano, halogen, nitro, formyl, NR^6R^7 , C_1-C_6 -haloalkyl, C_6-C_{12} -cycloalkylcycloalkyl, C_2-C_6 -alkenyl, C_2-C_6 -haloalkenyl, C_2-C_6 -alkynyl, C_2-C_6 -haloalkynyl, C_3-C_{12} -trialkylsilyl, phenyl, hydroxyl, oxo, C_1-C_6 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy, C_1-C_6 -haloalkoxy, C_2-C_6 -alkenyloxy, C_2-C_6 -alkynyloxy, C_3-C_6 -cycloalkyloxy, C_3-C_6 -cycloalkyl- C_1-C_4 -alkyloxy, C_3-C_6 -halocycloalkyloxy, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkylcarbonyloxy, C_1-C_6 -alkylcarbonyl, C_1-C_6 -alkylthio, C_1-C_6 -haloalkylthio or phenoxy, and more preferably cyano, nitro, fluorine, chlorine, formyl, fluoromethyl, chloromethyl, bromomethyl, dichloromethyl, trichloromethyl, difluoromethyl, trifluoromethyl, chlorofluoromethyl, dichlorofluoromethyl, chlorodifluoromethyl, 1-chloroethyl, 1-bromoethyl, 1-fluoroethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, 2-chloro-2-fluoroethyl, 2-chloro-2-difluoroethyl, 2,2-dichloro-2-fluoroethyl, 2,2,2-tri chloroethyl, pentafluoroethyl, 1,1,1-trifluoroprop-2-yl, 1,1'-bi(cycloprop-2-yl), ethenyl, 1-propenyl, 2-propenyl, 1-methylethenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-methyl-1-propenyl, 2-methyl-1-propenyl, 1-methyl-2-propenyl, 2-methyl-2-propenyl, 2,2-difluoroethenyl, fluoroethenyl, 1-fluoroprop-2-en-1-yl, 1-chloroprop-2-en-1-yl, 3-fluoroprop-1-en-1-yl, 3-chloroprop-1-en-1-yl, ethynyl, 2-propenyl, 1-propenyl, phenyl, oxo, methoxy, ethoxy, propoxy, 1-methylethoxy, methoxymethoxy, methoxyethoxy, methylthio, ethylthio, propylthio, 1-methylethylthio, chloromethoxy, bromomethoxy, dichloromethoxy, trichloromethoxy, fluoromethoxy, difluoromethoxy, trifluoromethoxy, chlorofluoromethoxy, dichlorofluoromethoxy, chlorodifluoromethoxy, 1-chloroethoxy, 1-bromoethoxy, 1-fluoroethoxy, 2-fluoroethoxy, 2,2-difluoroethoxy, 2,2,2-trifluoroethoxy, 2-chloro-2-fluoroethoxy, 2-chloro, 2-difluoroethoxy, 2,2-dichloro-2-fluoroethoxy, 2,2,2-trichloroethoxy, pentafluoroethoxy, cyclo-

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propyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, 2-fluorocyclohexyloxy, 2-chlorocyclohexyloxy, 2-fluorocyclopentyl, 2-chlorocyclopentyl, and most preferably cyano, nitro, fluorine, chlorine, formyl, fluoromethyl, chloromethyl, bromomethyl, dichloromethyl, trichloromethyl, difluoromethyl, trifluoromethyl, chlorofluoromethyl, dichlorofluoromethyl, chlorodifluoromethyl, 1-chloroethyl, 1-bromoethyl, 1-fluoroethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, 2-chloro-2-fluoroethyl, 2-chloro-2-difluoroethyl, 2,2-dichloro-2-fluoroethyl, 2,2,2-trichloroethyl, pentafluoroethyl, 1,1,1-trifluoroprop-2-yl, 5
 Z^{1b} , Z^{1c} , Z^{1d} , Z^{1e} are the same or different and are preferably each independently cyano, halogen, nitro, NR^6R^7 , C_1-C_6 -alkyl, C_1-C_6 -haloalkyl, C_3-C_6 -cycloalkyl, C_3-C_6 -cycloalkyl- C_3-C_6 -cycloalkyl, C_2-C_6 -alkenyl, C_2-C_6 -haloalkenyl, C_2-C_6 -alkynyl, C_2-C_6 -haloalkynyl, C_3-C_{12} -trialkylsilyl, phenyl, hydroxyl, oxo, C_1-C_6 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy, C_1-C_6 -haloalkoxy, C_2-C_6 -alkenyloxy, C_2-C_6 -alkynyloxy, C_3-C_6 -cycloalkyloxy, C_2-C_8 -cycloalkyl- C_1-C_4 -alkyloxy, C_3-C_6 -halocycloalkyloxy, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkylcarbonyloxy, C_1-C_6 -alkylcarbonyl, C_1-C_6 -alkylthio, C_1-C_6 -haloalkylthio or phenoxy, and more preferably cyano, nitro, fluorine, chlorine, formyl, methyl, ethyl, propyl, 1-methyl-ethyl, fluoromethyl, chloromethyl, bromomethyl, dichloromethyl, trichloromethyl, difluoromethyl, trifluoromethyl, chlorofluoromethyl, dichlorofluoromethyl, chlorodifluoromethyl, 1-chloroethyl, 1-bromoethyl, 1-fluoroethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, 2-chloro-2-fluoroethyl, 2-chloro-2-difluoroethyl, 2,2-dichloro-2-fluoroethyl, 2,2,2-trichloroethyl, pentafluoroethyl, 1,1,1-trifluoroprop-2-yl, cyclopropyl, cyclopentyl, cyclohexyl, 1,1'-bi(cycloprop-2-yl), ethenyl, 1-propenyl, 2-propenyl, 1-methyl ethenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-methyl-1-propenyl, 2-methyl-1-propenyl, 1-methyl-2-propenyl, 2-methyl-2-propenyl, 2,2-difluoroethenyl, fluoroethenyl, 1-fluoroprop-2-en-1-yl, 1-chloroprop-2-en-1-yl, 3-fluoroprop-1-en-1-yl, 3-chloroprop-1-en-1-yl, ethynyl, 2-propenyl, 1-propenyl, phenyl, oxo, methoxy, ethoxy, propoxy, 1-methylethoxy, methoxymethoxy, methoxyethoxy, methylthio, ethylthio, propylthio, 1-methylethylthio, chloromethoxy, bromomethoxy, dichloromethoxy, trichloromethoxy, fluoromethoxy, difluoromethoxy, trifluoromethoxy, chlorofluoromethoxy, dichlorofluoromethoxy, chlorodifluoromethoxy, 1-chloroethoxy, 1-bromoethoxy, 1-fluoroethoxy, 2-fluoroethoxy, 2,2-difluoroethoxy, 2,2,2-trifluoroethoxy, 2-chloro-2-fluoroethoxy, 2-chloro, 2-difluoroethoxy, 2,2-dichloro-2-fluoroethoxy, 2,2,2-trichloroethoxy, pentafluoroethoxy, cyclopropyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, 2-fluorocyclohexyloxy, 2-chlorocyclohexyloxy, 2-fluorocyclopentyl, 2-chlorocyclopentyl, and most preferably cyano, nitro, fluorine, chlorine, formyl, methyl, ethyl, propyl, 1-methylethyl, fluoromethyl, chloromethyl, bromomethyl, dichloromethyl, trichloromethyl, difluoromethyl, trifluoromethyl, chlorofluoromethyl, dichlorofluoromethyl, chlorodifluoromethyl, 1-chloroethyl, 1-bromoethyl, 1-fluoroethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, 2-chloro-2-fluoroethyl, 2-chloro-2-difluoroethyl, 2,2-dichloro-2-fluoroethyl, 2,2,2-trichloroethyl, pentafluoroethyl, 1,1,1-trifluoroprop-2-yl, cyclopropyl, cyclopentyl, cyclohexyl, 60
 Z^{1f} is preferably C_2-C_6 -alkenyl, C_2-C_6 -alkenylamino, C_2-C_6 -alkenyloxy, C_2-C_6 -alkenylthio, C_2-C_6 -alkynyl, C_2-C_6 -alkyny-

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lamino, C_2-C_6 -alkynyloxy, C_2-C_6 -alkynylthio, C_1-C_6 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkenyl, C_1-C_6 -alkoxy- C_1-C_4 -alkynyl, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy, C_1-C_6 -alkoxy- C_1-C_4 -alkoxy- C_1-C_4 -alkyl, C_1-C_6 -alkoxy- C_1-C_4 -alkoxycarbonyl, C_1-C_6 -alkoxy- C_1-C_4 -alkyl, C_1-C_6 -alkoxy- C_1-C_4 -alkylaminocarbonyl, C_1-C_6 -alkoxy- C_1-C_4 -alkylcarbonyl, C_1-C_6 -alkoxyamino, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkoxycarbonyl- C_1-C_4 -alkoxy, C_1-C_6 -alkoxycarbonyl- C_1-C_4 -alkyl, C_1-C_6 -alkoxycarbonylamino, C_1-C_6 -alkoxyhalo- C_1-C_4 -alkoxy, C_1-C_6 -alkoxyhalo- C_1-C_4 -alkyl, C_1-C_6 -alkyl, C_1-C_6 -alkylamino, C_1-C_6 -alkylamino- C_1-C_4 -alkyl, C_1-C_6 -alkylaminocarbonyl, C_1-C_6 -alkylaminocarbonyl- C_1-C_4 -alkylamino, C_1-C_6 -alkylaminocarbonylamino, C_1-C_6 -alkylaminosulphonyl, C_1-C_6 -alkylaminothiocarbonyl, C_1-C_6 -alkylaminothiocarbonylamino, C_1-C_6 -alkylcarbonyl, C_1-C_6 -alkylcarbonyl- C_1-C_4 -alkoxy, C_1-C_6 -alkylcarbonylamino, C_1-C_6 -alkylcarbonyloxy, C_1-C_6 -alkylcarbonylthio, C_1-C_6 -alkyl- C_3-C_6 -cycloalkyl, C_1-C_6 -alkyl- C_3-C_6 -cycloalkyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphanyl, C_1-C_6 -alkylsulphanyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphonyl, C_1-C_6 -alkylsulphonyl- C_1-C_4 -alkyl, C_1-C_6 -alkylsulphonylamino, C_1-C_6 -alkylsulphonylamino- C_1-C_4 -alkyl, C_1-C_6 -alkylthio, C_1-C_6 -alkylthio- C_1-C_4 -alkyl, C_1-C_6 -alkylthiocarbonyl, C_1-C_6 -alkylthiocarbonyloxy, amino, aminocarbonyl, $C(=N-OR^7)R^8$, $C(=O)H$, $C(=O)NHCN$, $C(=O)OH$, cyano, C_1-C_6 -cyanoalkoxy, C_1-C_6 -cyanoalkyl, C_3-C_8 -cycloalkenyl, C_3-C_6 -cycloalkenyloxy- C_1-C_4 -alkyl, C_3-C_8 -cycloalkoxy, C_3-C_6 -cycloalkoxy- C_1-C_4 -alkyl, C_3-C_8 -cycloalkoxycarbonyl, C_3-C_8 -cycloalkyl, C_4-C_8 -cycloalkyl- C_1-C_4 -alkoxy, C_3-C_6 -cycloalkyl- C_1-C_4 -alkoxycarbonyl, C_3-C_6 -cycloalkyl- C_1-C_4 -alkyl, C_3-C_6 -cycloalkyl- C_1-C_4 -alkylamino, C_3-C_6 -cycloalkyl- C_1-C_4 -alkylamino- C_1-C_4 -alkyl, C_3-C_6 -cycloalkylamino, C_3-C_6 -cycloalkylamino- C_1-C_4 -alkyl, C_3-C_6 -cycloalkylaminocarbonyl, C_3-C_8 -cycloalkylcarbonyl, C_3-C_6 -cycloalkylcarbonyloxy, C_3-C_6 -cycloalkyl- C_3-C_6 -cycloalkyl, C_3-C_8 -cycloalkylsulphonyl, C_3-C_8 -cycloalkylthio, C_2-C_8 -dialkoxy- C_1-C_4 -alkyl, C_2-C_8 -dialkylamino, C_2-C_8 -dialkylamino- C_1-C_4 -alkyl, C_2-C_8 -dialkylaminocarbonyl, C_2-C_8 -dialkylaminocarbonylamino, C_2-C_8 -dialkylaminosulphonyl, C_2-C_8 -dialkylaminothiocarbonyl, C_2-C_8 -dialkylaminothiocarbonylamino, halogen, C_2-C_8 -haloalkenyl, C_2-C_8 -haloalkenyloxy, C_2-C_8 -haloalkynyl, C_2-C_8 -haloalkynyloxy, C_1-C_6 -haloalkoxy, C_1-C_6 -haloalkoxy- C_1-C_4 -alkoxy, C_1-C_6 -haloalkoxy- C_1-C_4 -alkyl, C_1-C_8 -haloalkoxyamino, C_1-C_6 -haloalkoxycarbonyl, C_1-C_6 -haloalkoxycarbonylamino, C_1-C_6 -haloalkoxy- C_1-C_4 -haloalkoxy, C_1-C_6 -haloalkoxy- C_1-C_4 -haloalkyl, C_1-C_6 -haloalkyl, C_1-C_6 -haloalkylamino, C_1-C_6 -haloalkylamino- C_1-C_4 -alkyl, C_1-C_6 -haloalkylcarbonyl, C_1-C_6 -haloalkylcarbonylamino, C_1-C_6 -haloalkylcarbonyloxy, C_1-C_6 -haloalkylsulphanyl, C_1-C_6 -haloalkylsulphonyl, C_1-C_6 -haloalkylsulphonylamino, C_1-C_6 -haloalkylsulphonylamino- C_1-C_4 -alkyl, C_3-C_8 -halocycloalkenyl, C_3-C_6 -halocycloalkenyloxy- C_1-C_4 -alkyl, C_3-C_8 -halocycloalkoxy, C_3-C_6 -halocycloalkoxy- C_1-C_4 -alkyl, C_3-C_8 -halocycloalkyl, C_3-C_6 -halocycloalkyl- C_1-C_4 -alkyl, C_3-C_8 -halocycloalkylcarbonyloxy, C_2-C_8 -halodialkylamino, C_2-C_8 -halodialkylamino- C_1-C_4 -alkyl, hydroxyl, C_1-C_6 -hydroxyalkyl, $NHCHO$, $NHCN$, nitro, phenylsulphonylamino, SF_5 , SO_2NHCN , thioxy, C_3-C_{12} -trialkylsilyl, hydrogen,

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Z^{1f} is more preferably hydrogen, fluorine, chlorine, nitro, trifluoromethyl, $C(=O)H$, methyl, ethyl, methoxy, ethoxy, prop-2-yn-1-yloxy, but-2-yn-1-yloxy, pent-2-yn-1-yloxy, but-3-yn-1-yloxy, but-3-en-1-yloxy, 3-chloroprop-2-yn-1-yloxy, cyanomethoxy, allyloxy,

Z^{1g} is preferably cyano, nitro, halogen, NR^6R^7 , C_1 - C_6 -alkyl, C_1 - C_4 -haloalkyl, C_3 - C_6 -cycloalkyl, C_1 - C_6 -alkenyl, C_1 - C_6 -haloalkenyl, C_2 - C_6 -alkynyl, C_2 - C_6 -haloalkynyl, C_3 - C_{12} -trialkylsilyl, benzyl, phenyl, hydroxyl, SH, C_1 - C_6 -alkoxy, C_1 - C_6 -haloalkoxy, C_2 - C_6 -alkenyloxy, C_2 - C_6 -alkynyloxy, C_1 - C_6 -alkylthio or C_1 - C_6 -haloalkylthio, and more preferably fluorine, chlorine, methyl, ethyl, trifluoromethyl, cyclopropyl, cyclopentyl, cyclohexyl, methylene, difluoromethylene, dichloromethylene, methoxy, ethoxy,

Z^{1h} , Z^{1j} and Z^{1i} are the same or different and are preferably each independently hydrogen, cyano, nitro, halogen, $-NR^3R^4$, C_1 - C_6 -alkyl, C_2 - C_6 -alkenyl, C_2 - C_6 -alkynyl, C_1 - C_6 -haloalkyl, C_2 - C_6 -haloalkenyl, C_2 - C_6 -haloalkynyl, C_3 - C_8 -cycloalkyl, C_3 - C_8 -halocycloalkyl, C_3 - C_8 -halocycloalkyl, C_1 - C_4 -alkyl- C_3 - C_8 -cycloalkyl, C_3 - C_8 -cycloalkyl- C_1 - C_4 -alkyl, C_1 - C_4 -alkoxy- C_1 - C_4 -alkyl, C_3 - C_8 -cycloalkoxy- C_1 - C_4 -alkyl, C_1 - C_4 -alkoxy- C_1 - C_4 -alkoxy- C_1 - C_4 -alkyl, C_1 - C_4 -alkylthio- C_1 - C_4 -alkyl, C_1 - C_6 -alkoxy, C_1 - C_6 -haloalkoxy, C_3 - C_8 -cycloalkoxy, C_3 - C_8 -halocycloalkoxy, C_3 - C_8 -cycloalkyl- C_1 - C_4 -alkoxy, C_2 - C_6 -alkenyloxy, C_2 - C_6 -haloalkenyloxy, C_2 - C_6 -alkynyloxy, C_2 - C_6 -haloalkynyloxy, C_1 - C_6 -alkoxy- C_1 - C_4 -alkoxy, C_1 - C_6 -alkylcarbonyloxy, C_1 - C_6 -haloalkylcarbonyloxy, C_3 - C_8 -cycloalkylcarbonyloxy, C_1 - C_6 -alkylcarbonyl- C_1 - C_6 -alkoxy, C_1 - C_6 -alkylthio, C_1 - C_6 -haloalkylthio, C_3 - C_8 -cycloalkylthio, and more preferably hydrogen, fluorine, chlorine, cyano, methyl, methoxy, ethoxy, trifluoromethyl, difluoromethyl or methoxymethyl, or most preferably hydrogen,

Z^{1i} , Z^{1k} and Z^{1m} are the same or different and are preferably each independently hydrogen, $-C(=O)H$, C_1 - C_3 -alkyl, C_1 - C_6 -alkylcarbonyl, C_1 - C_6 -alkoxycarbonyl, benzyloxy-carbonyl or benzyl and more preferably hydrogen, $-C(=O)H$, methyl, ethyl, methylcarbonyl, ethylcarbonyl, methoxycarbonyl, tert-butoxycarbonyl, benzyloxy-carbonyl or benzyl,

R^{10} is preferably hydrogen, oxo, cyano, halogen, C_1 - C_4 -alkyl, C_1 - C_4 -haloalkyl, C_3 - C_6 -cycloalkyl, C_1 - C_4 -alkoxy, and more preferably hydrogen, oxo, methyl, methoxy,

R^{11} is preferably hydrogen, $-C(=O)H$, C_1 - C_3 -alkyl, C_1 - C_6 -alkylcarbonyl, C_1 - C_6 -alkoxycarbonyl, benzyloxy-carbonyl, or benzyl, and more preferably hydrogen, $-C(=O)H$, methyl, methylcarbonyl, methoxycarbonyl, benzyloxy-carbonyl, benzyl.

The heteroaryl/piperidine and -piperazine derivatives usable in accordance with the invention are defined in general terms by the formula (I). The radical definitions of the radical definitions above and specified below of the formula (I) apply to the end products of the formula (I), and also equally to all intermediates (see also below under "Elucidations of the processes and intermediates").

The radical definitions and elucidations listed above and below, in general terms or in areas of preference, can be combined with one another as desired, i.e. including combinations between the particular areas and areas of preference. They apply both to the end products and correspondingly to precursors and intermediates. In addition, individual definitions may not apply.

Preference is given to those compounds of the formula (I) in which all radicals have the abovementioned preferred definitions.

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Particular preference is given to those compounds of the formula (I) in which all radicals have the abovementioned more preferred definitions.

Very particular preference is given to those compounds of the formula (I) in which all radicals have the abovementioned most preferred definitions.

Preference is additionally given to compounds of the formula (I) and agrochemically active salts, metal complexes and N-oxides thereof, in which:

A is 3,5-bis(difluoromethyl)-1H-pyrazol-1-yl, or A is 5-methyl-3-(trifluoromethyl)-1H-pyrazol-1-yl, or A is 5-chloro-2-methylphenyl;

L^1 is $-CH_2-$ or L^1 is $-NH-$;

Y^1 is oxygen;

p is 0;

G is G^1 ;

R^{G1} is hydrogen;

Q^1 is Q^{24-3} ;

R^5 is hydrogen;

Y^2 is oxygen;

Y^3 is oxygen or $-(NR^{13})-$;

R^{13} is hydrogen or methyl;

R^1 is 2-fluorocyclohexyl or

R^1 is 2-phenylcyclohexyl or

R^1 is 2-cyanocyclohexyl or

R^1 is 2-chlorocyclohexyl or

R^1 is 1,2,3,4-tetrahydronaphthalen-1-yl or

R^1 is 2,6-difluorobenzyl or

R^1 is 2-chlorobenzyl or

R^1 is 2,4-dichlorobenzyl.

The radical definitions specified above can be combined with one another as desired. In addition, individual definitions may not apply.

According to the type of substituents defined above, the compounds of the formula (I) have acidic or basic properties and can form salts, possibly also internal salts or adducts, with inorganic or organic acids or with bases or with metal ions. If the compounds of the formula (I) bear amino, alkylamino or other groups which induce basic properties, these compounds can be reacted with acids to give salts, or they are obtained directly as salts by the synthesis. If the compounds of the formula (I) bear hydroxyl, carboxyl or other groups which induce acidic properties, these compounds can be reacted with bases to give salts. Suitable bases are, for example, hydroxides, carbonates, hydrogenocarbonates of the alkali metals and alkaline earth metals, especially those of sodium, potassium, magnesium and calcium, and also ammonia, primary, secondary and tertiary amines having C_1 - C_4 -alkyl groups, mono-, di- and trialkanolamines of C_1 - C_4 -alkanols, choline and chlorocholine.

The salts obtainable in this way likewise have fungicidal properties.

Examples of inorganic acids are hydrohalic acids, such as hydrogen fluoride, hydrogen chloride, hydrogen bromide and hydrogen iodide, sulphuric acid, phosphoric acid and nitric acid, and acidic salts, such as $NaHSO_4$ and $KHSO_4$. Useful organic acids come, for example, formic acid, carbonic acid and alkanolic acids such as acetic acid, trifluoroacetic acid, trichloroacetic acid and propionic acid, and also glycolic acid, thiocyanic acid, lactic acid, succinic acid, citric acid, benzoic acid, cinnamic acid, oxalic acid, saturated or mono- or diunsaturated C_6 - C_{20} fatty acids, alkylsulphuric monoesters, alkylsulphonic acids (sulphonic acids having straight-chain or branched alkyl radicals having 1 to 20 carbon atoms), arylsulphonic acids or arylsulphonic acids (aromatic radicals, such as phenyl and naphthyl, which bear one or two sulphonic acid groups), alkylphosphonic acids

(phosphonic acids having straight-chain or branched alkyl radicals having 1 to 20 carbon atoms), arylphosphonic acids or arylidiphosphonic acids (aromatic radicals, such as phenyl and naphthyl, which bear one or two phosphonic acid radicals), where the alkyl and aryl radicals may bear further substituents, for example p-toluenesulphonic acid, salicylic acid, p-aminosalicylic acid, 2-phenoxybenzoic acid, 2-acetoxybenzoic acid, etc.

Useful metal ions are especially the ions of the elements of the second main groups, especially calcium and magnesium, of the third and fourth main groups, especially aluminium, tin and lead, and also of the first to eighth transition groups, especially chromium, manganese, iron, cobalt, nickel, copper, zinc and others. Particular preference is given to the metal ions of the elements of the fourth period. The metals may be present in the different valences that they can assume.

Optionally substituted groups may be mono- or polysubstituted, where the substituents in the case of polysubstitutions may be the same or different.

In the definitions of the symbols given in the above formulae, collective terms were used, which are generally representative of the following substituents:

Halogen: fluorine, chlorine, bromine and iodine and preferably fluorine, chlorine, bromine and more preferably fluorine, chlorine.

Alkyl: saturated, straight-chain or branched hydrocarbyl radicals having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms, for example (but not limited to) C₁-C₆-alkyl such as methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, 1,1-dimethylethyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethyl-1-methylpropyl and 1-ethyl-2-methylpropyl. This definition also applies to alkyl as part of a composite substituent, for example cycloalkylalkyl, hydroxyalkyl etc., unless defined elsewhere like, for example, alkylthio, alkylsulphinyl, alkylsulphonyl, haloalkyl or haloalkylthio. If the alkyl is at the end of a composite substituent, as, for example, in alkylcycloalkyl, the part of the composite substituent at the start, for example the cycloalkyl, may be mono- or polysubstituted identically or differently and independently by alkyl. The same also applies to composite substituents in which other radicals, for example alkenyl, alkynyl, hydroxyl, halogen, formyl etc., are at the end.

Alkenyl: unsaturated, straight-chain or branched hydrocarbyl radicals having 2 to 8, preferably 2 to 6, carbon atoms and one double bond in any position, for example (but not limited to) C₂-C₆-alkenyl such as ethenyl, 1-propenyl, 2-propenyl, 1-methylethenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-methyl-1-propenyl, 2-methyl-1-propenyl, 1-methyl-2-propenyl, 2-methyl-2-propenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 1-methyl-1-butenyl, 2-methyl-1-butenyl, 3-methyl-1-butenyl, 1-methyl-2-butenyl, 2-methyl-2-butenyl, 3-methyl-2-butenyl, 1,1-dimethyl-2-propenyl, 1,2-dimethyl-1-propenyl, 1,2-dimethyl-2-propenyl, 1-ethyl-1-propenyl, 1-ethyl-2-propenyl, 1-hexenyl, 2-hexenyl, 3-hexenyl, 4-hexenyl, 5-hexenyl, 1-methyl-1-pentenyl, 2-methyl-1-pentenyl, 3-methyl-1-pentenyl, 4-methyl-1-pentenyl, 1-methyl-2-pentenyl, 2-methyl-2-pentenyl, 3-methyl-2-pentenyl, 4-methyl-2-pentenyl, 1-methyl-3-pentenyl, 2-methyl-3-pentenyl, 3-methyl-3-pentenyl, 4-methyl-3-pentenyl, 1-methyl-4-pentenyl, 2-methyl-4-pentenyl, 3-methyl-4-pentenyl,

4-methyl-4-pentenyl, 1,1-dimethyl-2-butenyl, 1,1-dimethyl-3-butenyl, 1,2-dimethyl-1-butenyl, 1,2-dimethyl-2-butenyl, 1,2-dimethyl-3-butenyl, 1,3-dimethyl-1-butenyl, 1,3-dimethyl-2-butenyl, 1,3-dimethyl-3-butenyl, 2,2-dimethyl-3-butenyl, 2,3-dimethyl-1-butenyl, 2,3-dimethyl-2-butenyl, 2,3-dimethyl-3-butenyl, 3,3-dimethyl-1-butenyl, 3,3-dimethyl-2-butenyl, 1-ethyl-1-butenyl, 1-ethyl-2-butenyl, 1-ethyl-3-butenyl, 2-ethyl-1-butenyl, 2-ethyl-2-butenyl, 2-ethyl-3-butenyl, 1,1,2-trimethyl-2-propenyl, 1-ethyl-1-methyl-2-propenyl, 1-ethyl-2-methyl-1-propenyl and 1-ethyl-2-methyl-2-propenyl. This definition also applies to alkenyl as part of a composite substituent, for example haloalkenyl etc., unless defined elsewhere.

Alkynyl: straight-chain or branched hydrocarbyl groups having 2 to 8, preferably 2 to 6, carbon atoms and one triple bond in any position, for example (but not limited to) C₂-C₆-alkynyl, such as ethynyl, 1-propynyl, 2-propynyl, 1-butylnyl, 2-butylnyl, 3-butylnyl, 1-methyl-2-propynyl, 1-pentylnyl, 2-pentylnyl, 3-pentylnyl, 4-pentylnyl, 1-methyl-2-butylnyl, 1-methyl-3-butylnyl, 2-methyl-3-butylnyl, 3-methyl-1-butylnyl, 1,1-dimethyl-2-propynyl, 1-ethyl-2-propynyl, 1-hexynyl, 2-hexynyl, 3-hexynyl, 4-hexynyl, 5-hexynyl, 1-methyl-2-pentylnyl, 1-methyl-3-pentylnyl, 1-methyl-4-pentylnyl, 2-methyl-3-pentylnyl, 2-methyl-4-pentylnyl, 3-methyl-1-pentylnyl, 3-methyl-4-pentylnyl, 4-methyl-1-pentylnyl, 4-methyl-2-pentylnyl, 1,1-dimethyl-2-butylnyl, 1,1-dimethyl-3-butylnyl, 1,2-dimethyl-3-butylnyl, 2,2-dimethyl-3-butylnyl, 3,3-dimethyl-1-butylnyl, 1-ethyl-2-butylnyl, 1-ethyl-3-butylnyl, 2-ethyl-3-butylnyl and 1-ethyl-1-methyl-2-propynyl. This definition also applies to alkynyl as part of a composite substituent, for example haloalkynyl etc., unless defined elsewhere.

Alkoxy: saturated, straight-chain or branched alkyloxy, alkenyloxy or alkynyloxy radicals having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms, for example (but not limited to) C₁-C₆-alkoxy such as methoxy, ethoxy, propoxy, 1-methylethoxy, butoxy, 1-methyl-propoxy, 2-methyl-propoxy, 1,1-dimethylethoxy, pentoxy, 1-methylbutoxy, 2-methylbutoxy, 3-methylbutoxy, 2,2-dimethylpropoxy, 1-ethylpropoxy, hexoxy, 1,1-dimethylpropoxy, 1,2-dimethylpropoxy, 1-methylpentoxy, 2-methylpentoxy, 3-methylpentoxy, 4-methylpentoxy, 1,1-dimethylbutoxy, 1,2-dimethylbutoxy, 1,3-dimethylbutoxy, 2,2-dimethylbutoxy, 2,3-dimethylbutoxy, 3,3-dimethylbutoxy, 1-ethylbutoxy, 2-ethylbutoxy, 1,1,2-trimethylpropoxy, 1,2,2-trimethylpropoxy, 1-ethyl-1-methylpropoxy and 1-ethyl-2-methylpropoxy or C₁-C₆-alkenyloxy such as but-3-en-1-yloxy and allyloxy or C₁-C₆-alkynyloxy such as prop-2-yn-1-yloxy, but-2-yn-1-yloxy, pent-2-yn-1-yloxy, but-3-yn-1-yloxy. This definition also applies to alkoxy as part of a composite substituent, for example haloalkoxy, alkynylalkoxy etc., unless defined elsewhere.

Alkylthio: saturated, straight-chain or branched alkylthio radicals having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms, for example (but not limited to) C₁-C₆-alkylthio such as methylthio, ethylthio, propylthio, 1-methylethylthio, butylthio, 1-methylpropylthio, 2-methylpropylthio, 1,1-dimethylethylthio, pentylthio, 1-methylbutylthio, 2-methylbutylthio, 3-methylbutylthio, 2,2-dimethylpropylthio, 1-ethylpropylthio, hexylthio, 1,1-dimethylpropylthio, 1,2-dimethylpropylthio, 1-methylpentylthio, 2-methylpentylthio, 3-methylpentylthio, 4-methylpentylthio, 1,1-dimethylbutylthio, 1,2-dimethylbutylthio, 1,3-dimethylbutylthio, 2,2-dimethylbutylthio, 2,3-dimethylbutylthio, 3,3-dimethylbutylthio, 1-ethylbutylthio, 2-ethylbutylthio, 1,1,2-trimethylpropylthio, 1,2,2-trimethylpropylthio, 1-ethyl-1-methylpropylthio and 1-ethyl-2-methylpropylthio. This definition also

applies to alkylthio as part of a composite substituent, for example haloalkylthio etc., unless defined elsewhere.

Alkoxyacetyl: an alkoxy group which has 1 to 6, preferably 1 to 3, carbon atoms (as specified above) and is bonded to the skeleton via a carbonyl group ($-\text{CO}-$). This definition also applies to alkoxyacetyl as part of a composite substituent, for example cycloalkylalkoxyacetyl etc., unless defined elsewhere.

Alkylsulphinyl: saturated, straight-chain or branched alkylsulphinyl radicals having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms, for example (but not limited to) C_1 - C_6 -alkylsulphinyl such as methylsulphinyl, ethylsulphinyl, propylsulphinyl, 1-methylethylsulphinyl, butylsulphinyl, 1-methylpropylsulphinyl, 2-methylpropylsulphinyl, 1,1-dimethylethylsulphinyl, pentylsulphinyl, 1-methylbutylsulphinyl, 2-methylbutylsulphinyl, 3-methylbutylsulphinyl, 2,2-dimethylpropylsulphinyl, 1-ethylpropylsulphinyl, hexylsulphinyl, 1,1-dimethylpropylsulphinyl, 1,2-dimethylpropylsulphinyl, 1-methylpentylsulphinyl, 2-methylpentylsulphinyl, 3-methylpentylsulphinyl, 4-methylpentylsulphinyl, 1,1-dimethylbutylsulphinyl, 1,2-dimethylbutylsulphinyl, 1,3-dimethylbutylsulphinyl, 2,2-dimethylbutylsulphinyl, 2,3-dimethylbutylsulphinyl, 3,3-dimethylbutylsulphinyl, 1-ethylbutylsulphinyl, 2-ethylbutylsulphinyl, 1,1,2-trimethylpropylsulphinyl, 1,2,2-trimethylpropylsulphinyl, 1-ethyl-1-methylpropylsulphinyl and 1-ethyl-2-methylpropylsulphinyl. This definition also applies to alkylsulphinyl as part of a composite substituent, for example haloalkylsulphinyl etc., unless defined elsewhere.

Alkylsulphonyl: saturated, straight-chain or branched alkylsulphonyl radicals having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms, for example (but not limited to) C_1 - C_6 -alkylsulphonyl such as methylsulphonyl, ethylsulphonyl, propylsulphonyl, 1-methylethylsulphonyl, butylsulphonyl, 1-methylpropylsulphonyl, 2-methylpropylsulphonyl, 1,1-dimethylethylsulphonyl, pentylsulphonyl, 1-methylbutylsulphonyl, 2-methylbutylsulphonyl, 3-methylbutylsulphonyl, 2,2-dimethylpropylsulphonyl, 1-ethylpropylsulphonyl, hexylsulphonyl, 1,1-dimethylpropylsulphonyl, 1,2-dimethylpropylsulphonyl, 1-methylpentylsulphonyl, 2-methylpentylsulphonyl, 3-methylpentylsulphonyl, 4-methylpentylsulphonyl, 1,1-dimethylbutylsulphonyl, 1,2-dimethylbutylsulphonyl, 1,3-dimethylbutylsulphonyl, 2,2-dimethylbutylsulphonyl, 2,3-dimethylbutylsulphonyl, 3,3-dimethylbutylsulphonyl, 1-ethylbutylsulphonyl, 2-ethylbutylsulphonyl, 1,1,2-trimethylpropylsulphonyl, 1,2,2-trimethylpropylsulphonyl, 1-ethyl-1-methylpropylsulphonyl and 1-ethyl-2-methylpropylsulphonyl. This definition also applies to alkylsulphonyl as part of a composite substituent, for example haloalkylsulphonyl etc., unless defined elsewhere.

Cycloalkyl: monocyclic, saturated hydrocarbyl groups having 3 to 10, preferably 3 to 8 and more preferably 3 to 6 carbon ring members, for example (but not limited to) cyclopropyl, cyclopentyl and cyclohexyl. This definition also applies to cycloalkyl as part of a composite substituent, for example cycloalkylalkyl etc., unless defined elsewhere.

Cycloalkenyl: monocyclic, partially unsaturated hydrocarbyl groups having 3 to 10, preferably 3 to 8 and more preferably 3 to 6 carbon ring members, for example (but not limited to) cyclopropenyl, cyclopentenyl and cyclohexenyl. This definition also applies to cycloalkenyl as part of a composite substituent, for example cycloalkenylalkyl etc., unless defined elsewhere.

Cycloalkoxy: monocyclic, saturated cycloalkyloxy groups having 3 to 10, preferably 3 to 8 and more preferably 3 to 6

carbon ring members, for example (but not limited to) cyclopropyloxy, cyclopentyloxy and cyclohexyloxy. This definition also applies to cycloalkoxy as part of a composite substituent, for example cycloalkoxyalkyl etc., unless defined elsewhere.

Haloalkyl: straight-chain or branched alkyl groups having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms (as specified above), where some or all of the hydrogen atoms in these groups may be replaced by halogen atoms as specified above, for example (but not limited to) C_1 - C_3 -haloalkyl such as chloromethyl, bromomethyl, dichloromethyl, trichloromethyl, fluoromethyl, difluoromethyl, trifluoromethyl, chlorofluoromethyl, dichlorofluoromethyl, chlorodifluoromethyl, 1-chloroethyl, 1-bromoethyl, 1-fluoroethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, 2-chloro-2-fluoroethyl, 2-chloro, 2-difluoroethyl, 1,2,2-dichloro-2-fluoroethyl, 2,2,2-trichloroethyl, pentafluoroethyl and 1,1,1-trifluoroprop-2-yl. This definition also applies to haloalkyl as part of a composite substituent, for example haloalkylaminoalkyl etc., unless defined elsewhere.

Haloalkenyl and haloalkynyl are defined analogously to haloalkyl except that, instead of alkyl groups, alkenyl and alkynyl groups are present as part of the substituent.

Haloalkoxy: straight-chain or branched alkoxy groups having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms (as specified above), where some or all of the hydrogen atoms in these groups may be replaced by halogen atoms as specified above, for example (but not limited to) C_1 - C_3 -haloalkoxy such as chloromethoxy, bromomethoxy, dichloromethoxy, trichloromethoxy, fluoromethoxy, difluoromethoxy, trifluoromethoxy, chlorofluoromethoxy, dichlorofluoromethoxy, chlorodifluoromethoxy, 1-chloroethoxy, 1-bromoethoxy, 1-fluoroethoxy, 2-fluoroethoxy, 2,2-difluoroethoxy, 2,2,2-trifluoroethoxy, 2-chloro-2-fluoroethoxy, 2-chloro, 2-difluoroethoxy, 2,2-dichloro-2-fluoroethoxy, 2,2,2-trichloroethoxy, pentafluoroethoxy and 1,1,1-trifluoroprop-2-oxy. This definition also applies to haloalkoxy as part of a composite substituent, for example haloalkoxyalkyl etc., unless defined elsewhere.

Haloalkylthio: straight-chain or branched alkylthio groups having 1 to 8, preferably 1 to 6 and more preferably 1 to 3 carbon atoms (as specified above), where some or all of the hydrogen atoms in these groups may be replaced by halogen atoms as specified above, for example (but not limited to) C_1 - C_3 -haloalkylthio such as chloromethylthio, bromomethylthio, dichloromethylthio, trichloromethylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, chlorofluoromethylthio, dichlorofluoromethylthio, chlorodifluoromethylthio, 1-chloroethylthio, 1-bromoethylthio, 1-fluoroethylthio, 2-fluoroethylthio, 2,2-difluoroethylthio, 2,2,2-trifluoroethylthio, 2-chloro-2-fluoroethylthio, 2-chloro, 2-difluoroethylthio, 2,2-dichloro-2-fluoroethylthio, 2,2,2-trichloroethylthio, pentafluoroethylthio and 1,1,1-trifluoroprop-2-ylthio. This definition also applies to haloalkylthio as part of a composite substituent, for example haloalkylthioalkyl etc., unless defined elsewhere.

Heteroaryl: 5 or 6-membered, fully unsaturated monocyclic ring system containing one to four heteroatoms from the group of oxygen, nitrogen and sulphur; if the ring contains more than one oxygen atom, they are not directly adjacent.

5-Membered heteroaryl containing one to four nitrogen atoms or one to three nitrogen atoms and one sulphur or oxygen atom: 5-membered heteroaryl ring groups which, in addition to carbon atoms, may contain one to four nitrogen atoms or one to three nitrogen atoms and one sulphur or oxygen atom as ring members, for example (but not limited to) 2-furyl, 3-furyl, 2-thienyl, 3-thienyl, 2-pyrrolyl, 3-pyrro-

lyl, 3-isoxazolyl, 4-isoxazolyl, 5-isoxazolyl, 3-isothiazolyl, 4-isothiazolyl, 5-isothiazolyl, 3-pyrazolyl, 4-pyrazolyl, 5-pyrazolyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 2-thiazolyl, 4-thiazolyl, 5-thiazolyl, 2-imidazolyl, 4-imidazolyl, 1,2,4-oxadiazol-3-yl, 1,2,4-oxadiazol-5-yl, 1,2,4-thiadiazol-3-yl, 1,2,4-thiadiazol-5-yl, 1,2,4-triazol-3-yl, 1,3,4-oxadiazol-2-yl, 1,3,4-thiadiazol-2-yl and 1,3,4-triazol-2-yl.

Nitrogen-bonded 5-membered heteroaryl containing one to four nitrogen atoms, or benzofused nitrogen-bonded 5-membered heteroaryl containing one to three nitrogen atoms: 5-membered heteroaryl ring groups which, in addition to carbon atoms, may contain one to four nitrogen atoms or one to three nitrogen atoms as ring members and in which two adjacent carbon ring members or one nitrogen and one adjacent carbon ring member may be bridged by a buta-1,3-diene-1,4-diyl group in which one or two carbon atoms may be replaced by nitrogen atoms, where these rings are attached to the skeleton via one of the nitrogen ring members, for example (but not limited to) 1-pyrrolyl, 1-pyrazolyl, 1,2,4-triazol-1-yl, 1-imidazolyl, 1,2,3-triazol-1-yl and 1,3,4-triazol-1-yl.

6-Membered heteroaryl containing one to four nitrogen atoms: 6-membered heteroaryl ring groups which, in addition to carbon atoms, may contain one to three or one to four nitrogen atoms as ring members, for example (but not limited to) 2-pyridinyl, 3-pyridinyl, 4-pyridinyl, 3-pyridazinyl, 4-pyridazinyl, 2-pyrimidinyl, 4-pyrimidinyl, 5-pyrimidinyl, 2-pyrazinyl, 1,3,5-triazin-2-yl, 1,2,4-triazin-3-yl and 1,2,4,5-tetrazin-3-yl.

Benzofused 5-membered heteroaryl containing one to three nitrogen atoms or one nitrogen atom and one oxygen or sulphur atom: for example (but not limited to) indol-1-yl, indol-2-yl, indol-3-yl, indol-4-yl, indol-5-yl, indol-6-yl, indol-7-yl, benzimidazol-1-yl, benzimidazol-2-yl, benzimidazol-4-yl, benzimidazol-5-yl, indazol-1-yl, indazol-3-yl, indazol-4-yl, indazol-5-yl, indazol-6-yl, indazol-7-yl, indazol-2-yl, 1-benzofuran-2-yl, 1-benzofuran-3-yl, 1-benzofuran-4-yl, 1-benzofuran-5-yl, 1-benzofuran-6-yl, 1-benzofuran-7-yl, 1-benzothiophen-2-yl, 1-benzothiophen-3-yl, 1-benzothiophen-4-yl, 1-benzothiophen-5-yl, 1-benzothiophen-6-yl, 1-benzothiophen-7-yl, 1,3-benzothiazol-2-yl, 1,3-benzothiazol-4-yl, 1,3-benzothiazol-5-yl, 1,3-benzothiazol-6-yl, 1,3-benzothiazol-7-yl, 1,3-benzoxazol-2-yl, 1,3-benzoxazol-4-yl, 1,3-benzoxazol-5-yl, 1,3-benzoxazol-6-yl and 1,3-benzoxazol-7-yl.

Benzofused 6-membered heteroaryl containing one to three nitrogen atoms: for example (but not limited to) quinolin-2-yl, quinolin-3-yl, quinolin-4-yl, quinolin-5-yl, quinolin-6-yl, quinolin-7-yl, quinolin-8-yl, isoquinolin-1-yl, isoquinolin-3-yl, isoquinolin-4-yl, isoquinolin-5-yl, isoquinolin-6-yl, isoquinolin-7-yl and isoquinolin-8-yl.

This definition also applies to heteroaryl as part of a composite substituent, for example heteroarylalkyl etc., unless defined elsewhere.

Heterocyclyl: three- to fifteen-membered, preferably three- to nine-membered, saturated or partially unsaturated heterocycle containing one to four heteroatoms from the group of oxygen, nitrogen and sulphur: mono-, bi- or tricyclic heterocycles which contain, in addition to carbon ring members, one to three nitrogen atoms and/or one oxygen or sulphur atom or one or two oxygen and/or sulphur atoms; if the ring contains more than one oxygen atom, they are not directly adjacent; for example (but not limited to) oxiranyl, aziridinyl, 2-tetrahydrofuranyl, 3-tetrahydrofuranyl, 2-tetrahydrothienyl, 3-tetrahydrothienyl, 2-pyrrolidinyl, 3-pyrrolidinyl, 3-isoxazolidinyl, 4-isoxazolidinyl, 5-isoxazolidinyl, 3-isothiazolidinyl, 4-isothiazolidinyl, 5-isothiazolidinyl,

3-pyrazolidinyl, 4-pyrazolidinyl, 5-pyrazolidinyl, 2-oxazolidinyl, 4-oxazolidinyl, 5-oxazolidinyl, 2-thiazolidinyl, 4-thiazolidinyl, 5-thiazolidinyl, 2-imidazolidinyl, 4-imidazolidinyl, 1,2,4-oxadiazolidin-3-yl, 1,2,4-oxadiazolidin-5-yl, 1,2,4-thiadiazolidin-3-yl, 1,2,4-thiadiazolidin-5-yl, 1,2,4-triazolidin-3-yl, 1,3,4-oxadiazolidin-2-yl, 1,3,4-thiadiazolidin-2-yl, 1,3,4-triazolidin-2-yl, 2,3-dihydrofur-2-yl, 2,3-dihydrofur-3-yl, 2,4-dihydrofur-2-yl, 2,4-dihydrofur-3-yl, 2,3-dihydrothien-2-yl, 2,3-dihydrothien-3-yl, 2,4-dihydrothien-2-yl, 2,4-dihydrothien-3-yl, 2-pyrrolin-2-yl, 2-pyrrolin-3-yl, 3-pyrrolin-2-yl, 3-pyrrolin-3-yl, 2-isoxazolin-3-yl, 3-isoxazolin-3-yl, 4-isoxazolin-3-yl, 2-isoxazolin-4-yl, 3-isoxazolin-4-yl, 4-isoxazolin-4-yl, 2-isoxazolin-5-yl, 3-isoxazolin-5-yl, 4-isoxazolin-5-yl, 2-isothiazolin-3-yl, 3-isothiazolin-3-yl, 4-isothiazolin-3-yl, 2-isothiazolin-4-yl, 3-isothiazolin-4-yl, 4-isothiazolin-4-yl, 2-isothiazolin-5-yl, 3-isothiazolin-5-yl, 4-isothiazolin-5-yl, 2,3-dihydropyrazol-1-yl, 2,3-dihydropyrazol-2-yl, 2,3-dihydropyrazol-3-yl, 2,3-dihydropyrazol-4-yl, 2,3-dihydropyrazol-5-yl, 3,4-dihydropyrazol-1-yl, 3,4-dihydropyrazol-3-yl, 3,4-dihydropyrazol-4-yl, 3,4-dihydropyrazol-5-yl, 4,5-dihydropyrazol-1-yl, 4,5-dihydropyrazol-3-yl, 4,5-dihydropyrazol-4-yl, 4,5-dihydropyrazol-5-yl, 2,3-dihydrooxazol-2-yl, 2,3-dihydrooxazol-3-yl, 2,3-dihydrooxazol-4-yl, 2,3-dihydrooxazol-5-yl, 3,4-dihydrooxazol-2-yl, 3,4-dihydrooxazol-3-yl, 3,4-dihydrooxazol-4-yl, 3,4-dihydrooxazol-5-yl, 3,4-dihydrooxazol-2-yl, 3,4-dihydrooxazol-3-yl, 3,4-dihydrooxazol-4-yl, 2-piperidinyl, 3-piperidinyl, 4-piperidinyl, 1,3-dioxan-5-yl, 2-tetrahydropyranyl, 4-tetrahydropyranyl, 2-tetrahydrothienyl, 3-hexahydropyridazinyl, 4-hexahydropyridazinyl, 2-hexahydropyrimidinyl, 4-hexahydropyrimidinyl, 5-hexahydropyrimidinyl, 2-piperazinyl, 1,3,5-hexahydrotriazin-2-yl and 1,2,4-hexahydrotriazin-3-yl. This definition also applies to heterocyclyl as part of a composite substituent, for example heterocyclylalkyl etc., unless defined elsewhere.

Leaving group: S_N1 or S_N2 leaving group, for example chlorine, bromine, iodine, alkylsulphonates ($-\text{OSO}_2\text{-alkyl}$, e.g. $-\text{OSO}_2\text{CH}_3$, $-\text{OSO}_2\text{CF}_3$) or arylsulphonates ($-\text{OSO}_2\text{-aryl}$, e.g. $-\text{OSO}_2\text{Ph}$, $-\text{OSO}_2\text{PhMe}$).

Not included are combinations which contravene the laws of nature and which the person skilled in the art would therefore rule out on the basis of his/her expert knowledge. Ring structures having three or more adjacent oxygen atoms, for example, are excluded.

Elucidation of the Preparation Processes and Intermediates

The heteroaryl piperidine and -piperazine derivatives of the formula (I) can be prepared in different ways. First of all, the possible processes are shown schematically below. Unless indicated otherwise, the radicals specified are each as defined above.

The processes according to the invention for preparing compounds of the formula (I) are optionally performed using one or more reaction auxiliaries.

Useful reaction auxiliaries are, if required, inorganic or organic bases or acid acceptors. These preferably include alkali metal or alkaline earth metal acetates, amides, carbonates, hydrogencarbonates, hydrides, hydroxides or alkoxides, for example sodium acetate, potassium acetate or calcium acetate, lithium amide, sodium amide, potassium amide or calcium amide, sodium carbonate, potassium carbonate or calcium carbonate, sodium hydrogencarbonate, potassium hydrogencarbonate or calcium hydrogencarbonate, lithium hydride, sodium hydride, potassium hydride or calcium hydride, lithium hydroxide, sodium hydroxide, potassium hydroxide or calcium hydroxide, sodium methoxide, ethox-

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ide, n- or i-propoxide, n-, i-, s- or t-butoxide or potassium methoxide, ethoxide, n- or i-propoxide, n-, i-, s- or t-butoxide; and also basic organic nitrogen compounds, for example trimethylamine, triethylamine, tripropylamine, tributylamine, ethyldiisopropylamine, N,N-dimethylcyclohexylamine, dicyclohexylamine, ethyldicyclohexylamine, N,N-dimethylaniline, N,N-dimethylbenzylamine, pyridine, 2-methyl-, 3-methyl-, 4-methyl-, 2,4-dimethyl-, 2,6-dimethyl-, 3,4-dimethyl- and 3,5-dimethylpyridine, 5-ethyl-2-methylpyridine, 4-dimethylaminopyridine, N-methylpiperidine, 1,4-diazabicyclo[2.2.2]-octane (DABCO), 1,5-diazabicyclo[4.3.0]-non-5-ene (DBN) or 1,8-diazabicyclo[5.4.0]-undec-7-ene (DBU).

The processes according to the invention are optionally performed using one or more diluents. Useful diluents include virtually all inert organic solvents. These preferably include aliphatic and aromatic, optionally halogenated hydrocarbons, such as pentane, hexane, heptane, cyclohexane, petroleum ether, benzene, ligroin, benzene, toluene, xylene, methylene chloride, ethylene chloride, chloroform, carbon tetrachloride, chlorobenzene and o-dichlorobenzene, ethers such as diethyl ether and dibutyl ether, glycol dimethyl ether and diglycol dimethyl ether, tetrahydrofuran and dioxane, ketones such as acetone, methyl ethyl ketone, methyl isopropyl ketone and methyl isobutyl ketone, esters, such as methyl acetate and ethyl acetate, nitriles, for example acetonitrile and propionitrile, amides, for example dimethylformamide, dimethylacetamide and N-methylpyrrolidone, and also dimethyl sulphoxide, tetramethylenesulphone and hexamethylphosphoramide and DMPU.

The reaction temperatures in the process according to the invention can be varied within a relatively wide range. In general, the temperatures employed are between 0° C. and 250° C., preferably temperatures between 10° C. and 185° C.

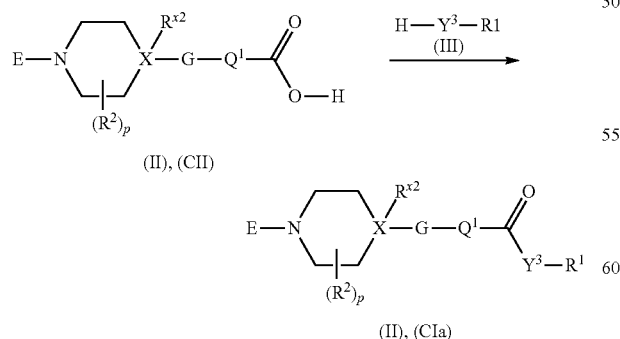
The reaction time varies as a function of the scale of the reaction and of the reaction temperature, but is generally between a few minutes and 48 hours.

The processes according to the invention are generally carried out under standard pressure. However, it is also possible to work under elevated or reduced pressure.

For performance of the processes according to the invention, the starting materials required in each case are generally used in approximately equimolar amounts. However, it is also possible to use one of the components used in each case in a relatively large excess.

Process A

Scheme 1: Process A



One means of preparing compounds of the formula (Ia) and (CIa) from corresponding compounds (II) and (CII) is shown in Scheme 1. When E is A-L¹(Y¹), the compounds are those

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of the formula (II) or (Ia). When E is acetyl, C₁-C₄-alkoxycarbonyl, benzyl or benzyloxycarbonyl, the compounds are those of the formula (CII) or (CIa).

Compounds of the formula (Ia) and (CIa) can be synthesized from corresponding compounds (II) and (CII) with a substrate of the formula (III) in the presence of a coupling reagent, analogously to methods known from the literature (e.g. *Tetrahedron*, 2005, 61, 10827-10852).

Suitable coupling reagents are, for example, peptide coupling reagents, for instance N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide mixed with 4-dimethylaminopyridine, N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide mixed with 1-hydroxybenzotriazole, bromotripyrrolidinophosphonium hexafluorophosphate, O-(7-azabenzotriazol-1-yl)-N,N,N',N'-tetramethyluronium hexafluorophosphate, etc.

If appropriate, a base, for example triethylamine or Hünig's base, can be used in the reaction.

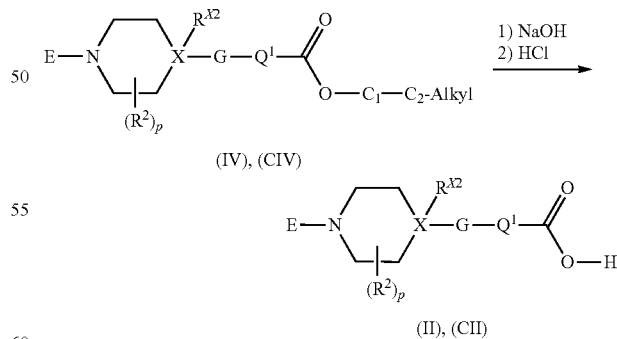
Alternatively, a compound of the formula (Ia) can also be synthesized proceeding from the compound of the formula (II) by a two-stage transformation using processes known from the literature (e.g. *Tetrahedron*, 2005, 61, 10827-10852), optionally in the presence of an acid scavenger/base. Typically, a compound of the formula (II) or (CII) is first converted to the corresponding acid halide or sulphonate, followed by a coupling reaction with a substrate of the formula (III).

Substrates with the general formula (III) are commercially available or preparable by processes described in the literature (see, for example, *The Chemistry of Functional groups*; *The Chemistry of the Thiol Group*; John Wiley & Sons, 1974, 163-269; *The Chemistry of Functional groups*; *Supplement F2: The Chemistry of amino, nitroso, nitro and related groups*; John Wiley & Sons; *Science of Synthesis*; *Alcohols*, Volume 36, Thieme, 2008; *Science of Synthesis*; *Amines and Ammonium Salts*, Volume 40a, Thieme, 2008).

After the reaction has ended, the compounds (Ia) and (CIa) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization, distillation or chromatography, or can optionally also be used in the next step without prior purification.

Process B

Scheme 2: Process B



One means of preparing the intermediates (II) and (CII) from corresponding compounds (IV) and (CIV) is shown in Scheme 2. When E is A-L¹(Y¹), the compounds are those of the formula (IV) or (CIV). When E is acetyl, C₁-C₄-alkoxycarbonyl, benzyl or benzyloxycarbonyl, the compounds are those of the formula (CIV) or (CII).

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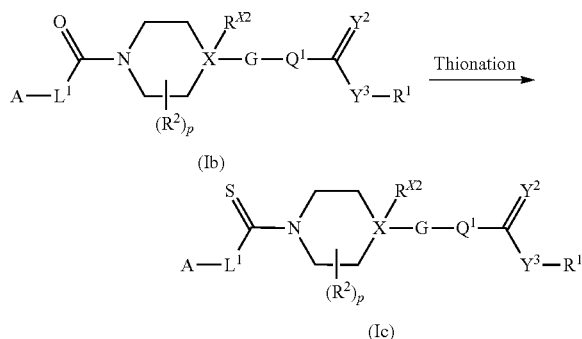
The carboxylic acids of the formula (II) and (CII) can be prepared by hydrolysis of the corresponding C₁-C₂-alkyl esters of the formula (IV) and (CIV). For example, the method which is described in WO2007/014290 can be used.

The solvents used may be all customary solvents which are inert under the reaction conditions, for example alcohols (e.g. methanol, ethanol, propanol), cyclic and acyclic ethers (for example diethyl ether, tetrahydrofuran, dioxane), aromatic hydrocarbons (e.g. benzene, toluene, xylene), halogenated hydrocarbons (e.g. dichloromethane, chloroform, carbon tetrachloride) and halogenated aromatic hydrocarbons (e.g. chlorobenzene, dichlorobenzene), or the reaction can be carried out in mixtures of two or more of these solvents.

Suitable alkali metal hydroxides are, for example, LiOH, NaOH or KOH, usually in the presence of water together with a cosolvent, preferably THF and/or methanol, to simplify dissolution of the ester. The starting material and the alkali metal hydroxide are employed in equimolar amounts; however, the alkali metal hydroxide may, if required, also be used in excess. The carboxylate salt formed is converted to the free acid by treatment with a slight excess of mineral acids, for example hydrochloric acid or sulphuric acid.

After the reaction has ended, the compounds (II) and (CII) are separated from the reaction mixture by one of the customary separation techniques. If required, the compounds are purified by recrystallization, distillation or chromatography.

Scheme 3: Process C



One means of preparing compounds of the formula (Ic) from corresponding compounds (Ib) is shown in Scheme 3.

The amides (Ib) obtained in the performance of process E according to the invention (Scheme 5; Y¹=O) can be converted by means of methods described in the literature to the corresponding thioamides (Ic) (e.g. *Bioorganic & Medicinal Chemistry Letters*, 2009, 19(2), 462-468). This involves reacting the compounds of the formula (Ib) typically with phosphorus pentasulphide or 2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane 2,4-disulphide (Lawesson's reagent).

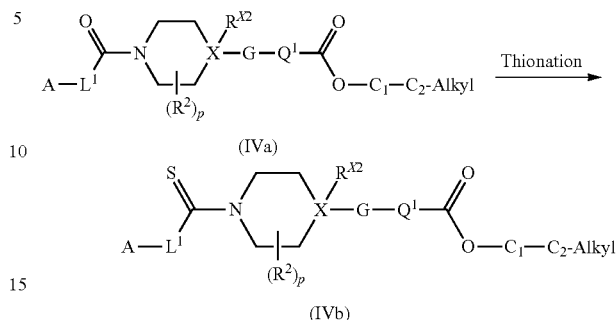
Process C according to the invention is preferably performed using one or more diluents. The preferred solvents are toluene, tetrahydrofuran and 1,2-dimethoxyethane.

After the reaction has ended, the compounds (Ic) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization or chromatography.

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Process D

Scheme 4: Process D

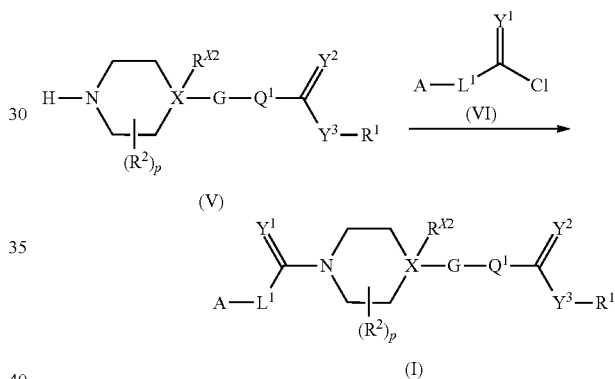


One means of preparing compounds of the formula (IVb) from corresponding compounds (IVa) is shown in Scheme 4.

The same process as already described in Scheme 3 (process C) is used.

Process E

Scheme 5: Process E



Process E describes the preparation of compounds of the structure (I) by reaction of acid chlorides (VI) with amines of the structure (V). It is likewise possible to use salts of the amines (V) as starting materials, typically the corresponding hydrochlorides, oxalates or trifluoroacetates.

The amides (I) (Y¹=O) obtained in the case of performance of process E according to the invention can be converted by methods described in the literature to the corresponding thioamides (for example *Bioorganic & Medicinal Chemistry Letters* (2009), 19(2), 462-468). This involves reacting the compounds of the formula (I) typically with phosphorus pentasulphide or 2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane 2,4-disulphide (Lawesson's reagent).

The carbonyl chlorides (VI) used in the case of performance of process E according to the invention are prepared by customary methods from the corresponding carboxylic acids (VIII). The carboxylic acids of the formula (VIII) are reacted with a chlorinating agent (e.g. thionyl chloride/oxalyl chloride) in the presence of a diluent (e.g. toluene or methylene chloride). To perform the chlorination, generally 0.5 to 20 mol, preferably 1 to 1.5 mol, of chlorinating agent are used per mole of compound of the formula (VIII). The reaction time is 1 to 48 hours. The reaction is preferably performed under a protective gas atmosphere, such as nitrogen or argon. The workup is effected by customary methods.

Process E is optionally performed in the presence of a suitable acid acceptor. Useful acid acceptors include all cus-

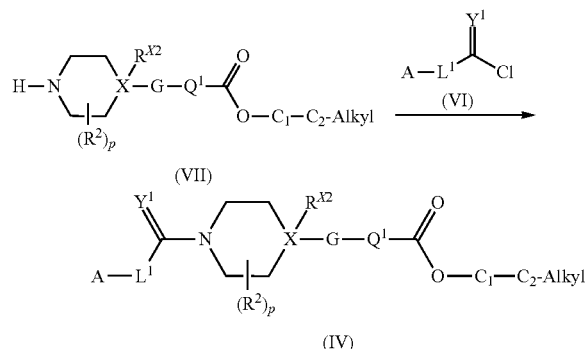
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tomary inorganic or organic bases. These preferably include the hydrides, hydroxides, amides, alkoxides, acetates, carbonates or bicarbonates of alkaline earth metals or alkali metals, for example sodium hydride, sodium amide, lithium diisopropylamide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium hydroxide, potassium hydroxide, sodium acetate, sodium carbonate, potassium carbonate, potassium hydrogencarbonate, sodium hydrogencarbonate or ammonium carbonate, and also tertiary amines, such as trimethylamine, triethylamine, tributylamine, N,N-diisopropylethylamine, N,N-dimethylaniline, N,N-dimethylbenzylamine, pyridine, N-methylpiperidine, N-methylmorpholine, N,N-dimethylaminopyridine, diazabicyclooctane (DABCO), diazabicyclononene (DBN) or diazabicycloundecene (DBU), and also polymer-bound acid acceptors, such as polymer-bound N,N-diisopropylethylamine or polymer-bound N,N-dimethylaminopyridine.

The reaction is preferably performed under a protective gas atmosphere, such as nitrogen or argon. The workup is effected by customary methods.

Process F

Scheme 6: Process F

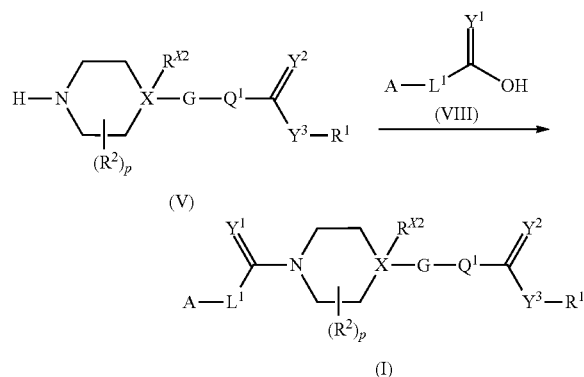


One means of preparing compounds of the formula (IV) from corresponding compounds (VII) is shown in Scheme 6.

The same process as already described in Scheme 5 (process E) is used.

Process G

Scheme 7: Process G



Process G describes the preparation of compounds of the structure (I) by reaction of carboxylic acids (VIII) with amines of the structure (V). It is likewise possible to use salts of the amines (V) as starting materials, typically the corresponding hydrochlorides, oxalates or trifluoroacetates.

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The amides (I) obtained in the case of performance of process G according to the invention can be converted by methods described in the literature to the corresponding thioamides (for example *Bioorganic & Medicinal Chemistry Letters* (2009), 19(2), 462-468; *European Journal of Organic Chemistry* (200), 19, 3273-3278). This involves reacting the compounds of the formula (I) typically with phosphorus pentasulphide or 2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane 2,4-disulphide (Lawesson's reagent).

The carboxylic acids (VII) used in the case of performance of process G according to the invention can be prepared by methods described in the literature.

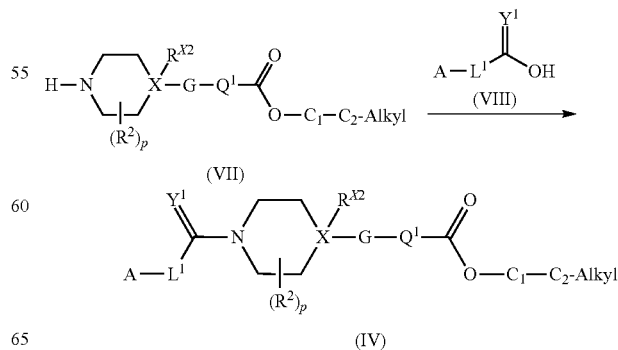
Suitable coupling reagents include all customary coupling reagents, for example dicyclohexylcarbodiimide (DCC), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC), O-benzotriazol-1-yl-N,N,N',N'-tetramethyluronium hexafluorophosphate (HBTU) or polymer-bound reagents, for example polymer-bound cyclohexylcarbodiimide.

Process G is optionally performed in the presence of a suitable acid acceptor. Useful acid acceptors include all customary inorganic or organic bases. These preferably include the hydrides, hydroxides, amides, alkoxides, acetates, carbonates or bicarbonates of alkaline earth metals or alkali metals, for example sodium hydride, sodium amide, lithium diisopropylamide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium hydroxide, potassium hydroxide, sodium acetate, sodium carbonate, potassium carbonate, potassium hydrogencarbonate, sodium hydrogencarbonate or ammonium carbonate, and also tertiary amines, such as trimethylamine, triethylamine, tributylamine, N,N-diisopropylethylamine, N,N-dimethylaniline, N,N-dimethylbenzylamine, pyridine, N-methylpiperidine, N-methylmorpholine, N,N-dimethylaminopyridine, diazabicyclooctane (DABCO), diazabicyclononene (DBN) or diazabicycloundecene (DBU), and also polymer-bound acid acceptors, such as polymer-bound N,N-diisopropylethylamine or polymer-bound N,N-dimethylaminopyridine.

To perform the reaction of process G according to the invention, generally 0.5 to 20 mol, preferably 1 to 2 mol, of compound (VIII) and 0 to 20 mol, preferably 1 to 5 mol, of acid acceptor, and also 1-10 mol, preferably 1 to 2 mol, of coupling reagent, are used per mole of the compound of the formula (V). The reaction time is 1 to 48 hours. The reaction is preferably performed under a protective gas atmosphere, such as nitrogen or argon. The workup is effected by customary methods.

Process H

Scheme 8: Process H



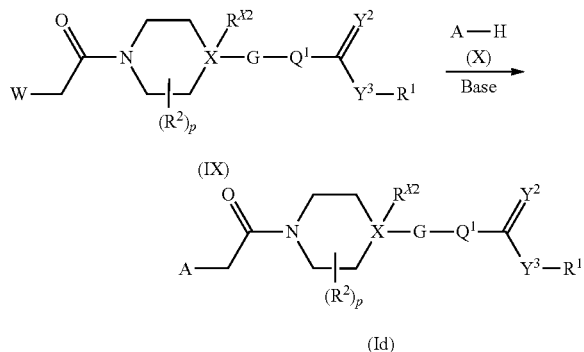
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One means of preparing compounds of the formula (IV) from corresponding compounds (VII) is shown in Scheme 8.

The same process as already described in Scheme 7 (process G) is used.

Process I

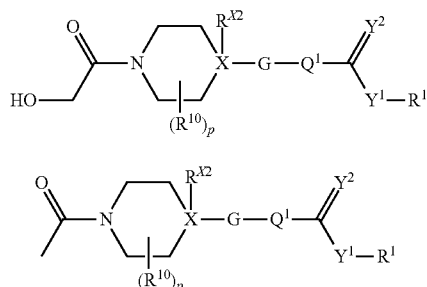
Scheme 9: Process I



One means of preparing compounds of the formula (Id) from corresponding compounds (IX) with the compounds (X) is shown in Scheme 9 (process I).

The starting materials (IX) in which W is a leaving group can be prepared by means of methods described in the literature from compounds (XI), (XII) (FIG. 1), or from (V) (see, for example, mesylation: *Organic Letters*, 2003, 2539-2541; tosylation: JP60156601; halogenation: *Australian Journal of Chemistry*, 1983, 2095-2110). Typically, the compounds of the formula (IX, W =chlorine) are prepared proceeding from an amide of the formula (V) and chloroacetyl chloride. The compounds (XI) in (FIG. 1) are prepared analogously to process G with glycolic acid or hydroxyacetyl chloride from (V) (see, for example, WO2007103187, WO2006117521, *Bioorganic & Medicinal Chemistry Letters*, 2007, 6326-6329).

Figure 1



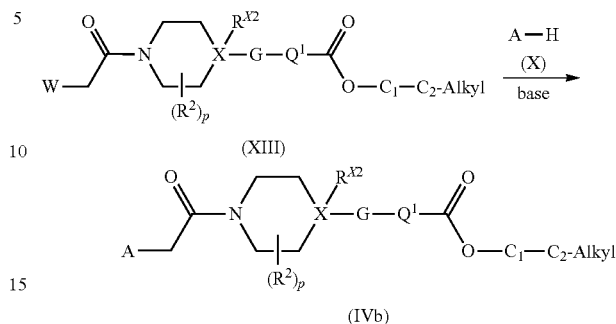
At least one equivalent of a base (e.g. sodium hydride, potassium carbonate) is used in relation to the starting material of the general formula (X).

After the reaction has ended, the compounds (Id) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization or chromatography, or can, if desired, also be used in the next step without prior purification.

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Process J

Scheme 10: Process J

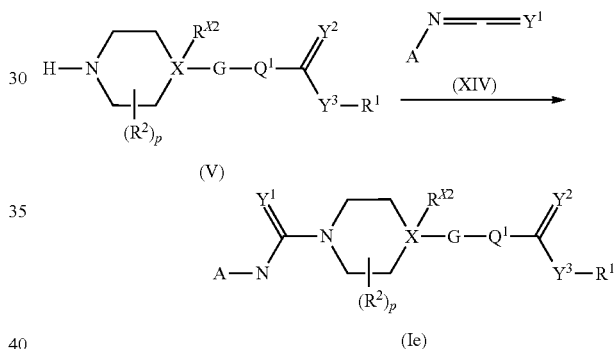


One means of preparing compounds of the formula (IVb) from corresponding compounds (XIII) is shown in process J (Scheme 10).

The same process as already described in Scheme 9 (process I) is used.

Process K

Scheme 11: Process K



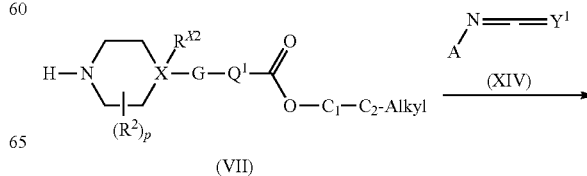
One means of preparing compounds of the formula (Ie) from corresponding compounds (V) with the compounds (XIV) is shown in Scheme 11 (process K).

A compound with the general formula (Ie) can be synthesized analogously to methods described in the literature (see, for example WO 2009/055514), by a coupling reaction of a compound with the corresponding general formula (V) with a substrate of the general formula (XIV), optionally in the presence of an acid scavenger/base, for example triethylamine, 1,8-diazabicyclo[5.4.0]undec-7-ene or Hünig's base.

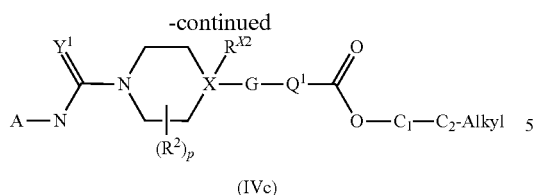
After the reaction has ended, the compounds (Ie) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization or chromatography.

Process L

Scheme 12: Process L



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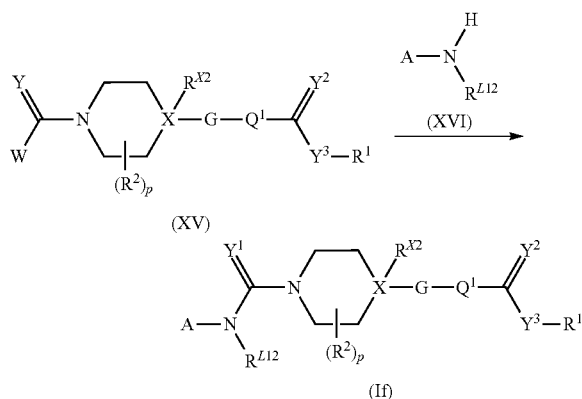


One means of preparing compounds of the formula (IVc) from corresponding compounds (VII) is shown in Scheme 12.

The same process as already described in Scheme 11 (process K) is used.

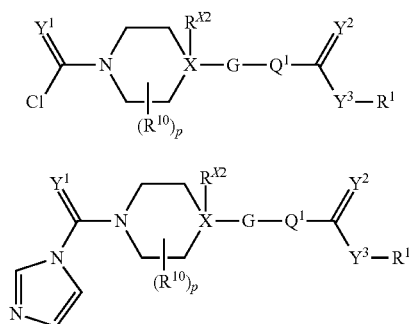
Process M

Scheme 13: Process M



One means of preparing compounds of the formula (If) from corresponding compounds XV (XVa or XVb, see FIG. 2) with the compounds (XVI) is shown in Scheme 13 (process M).

Figure 2



The starting materials, carbamoyl and thiocarbamoyl chlorides of the formula (XVa), can be prepared by means of methods described in the literature from compounds (V) (see, for example, *Tetrahedron*, 2008, 7605; *Journal of Organic Chemistry*, 2004, 3787; *Journal of Organic Chemistry*, 1983, 4750; *European Journal of Organic Chemistry*, 2006, 1177). Typically, the compounds of the formula (XVa) are prepared proceeding from amines of the formula (V) and phosgene, thiophosgene or the equivalents thereof.

The alternative starting materials, carbamoyl- and thiocarbamoylimidazoles of the formula (XVb), can be prepared by

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means of methods described in the literature (see, for example, *Tetrahedron Letters*, 2008, 5279; *Tetrahedron*, 2005, 7153). Typically, the compounds of the formula (XVb, W=imidazol-1-yl) are prepared proceeding from amines of the formula (V) and 1,1'-carbonyldiimidazole or 1,1'-thiocarbonyldiimidazole.

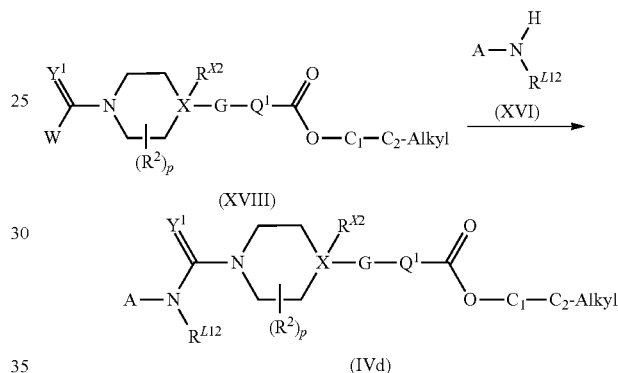
Process M is optionally performed in the presence of a suitable acid acceptor.

The compounds (If) obtained in the performance of process M according to the invention can alternatively in some cases also be obtained without using an acid acceptor, as corresponding acid chlorides [(If)-HCl]. If required, the compounds (If) are released by customary methods.

After the reaction has ended, the compounds (If) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization or chromatography.

Process N

Scheme 14: Process N

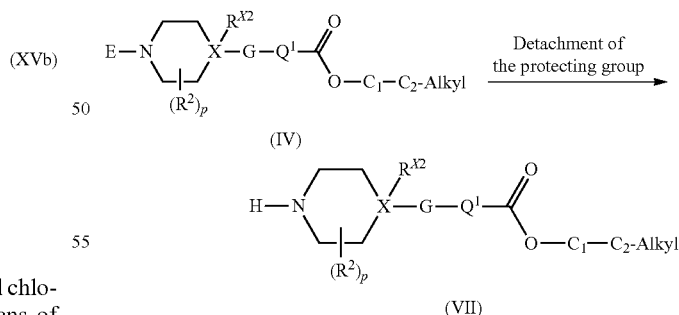


One means of preparing compounds of the formula (IVd) from corresponding compounds (XVIII) is shown in Scheme 14.

The same process as already described in Scheme 13 (process M) is used.

Process O

Scheme 15: Process O



One means of preparing compounds of the formula (VII) from corresponding compounds (IV) is shown in Scheme 15.

A compound of the formula (IV) is converted to a compound of the formula (VII) by suitable methods for removing protecting groups described in the literature ("*Protective Groups in Organic Synthesis*"; Third Edition; 494-653).

tert-Butoxycarbonyl and benzyloxycarbonyl protecting groups can be removed in an acidic medium (for example

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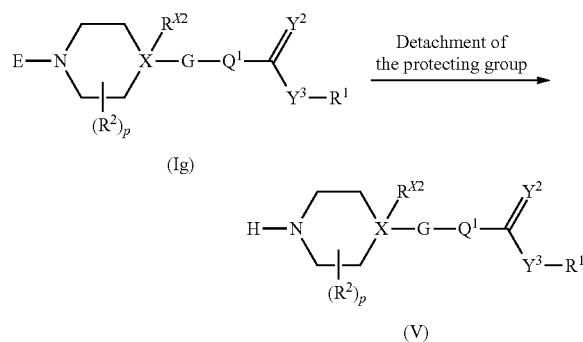
with hydrochloric acid or trifluoroacetic acid). Acetyl protecting groups can be removed under basic conditions (for example with potassium carbonate or caesium carbonate). Benzylic protecting groups can be removed hydrogenolytically with hydrogen in the presence of a catalyst (for example palladium on activated carbon).

Acids which can be used for this reaction, the deprotection of tert-butoxycarbonyl and benzyloxycarbonyl groups, are, for example, trifluoroacetic acid, hydrochloric acid or other acids, as described in the literature (for example "Protective Groups in Organic Synthesis"; Third Edition; pp. 494-653).

After the reaction has ended, the compounds (VII) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization, distillation or chromatography, or can, if desired, also be used in the next step without prior purification. It is also possible to isolate the compound of the general formula (VII) as a salt, for example as a salt of hydrochloric acid or of trifluoroacetic acid.

Process P

Scheme 16: Process P

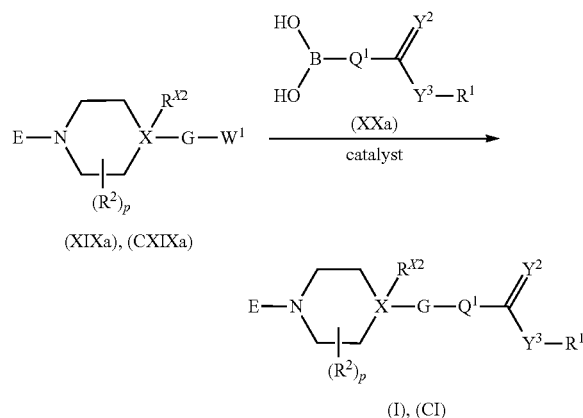


One means of preparing compounds of the formula (V) from corresponding compounds (Ig) is shown in Scheme 16.

The same process as already described in Scheme 15 (process O) is used.

Process Q

Scheme 17: Process Q



Compounds of the formula (I) and (CI) can generally be prepared according to process Q (Scheme 17) by palladium-catalysed Heck reaction, which may proceed from the corresponding boronic acids XXa and halides (e.g. iodides, bro-

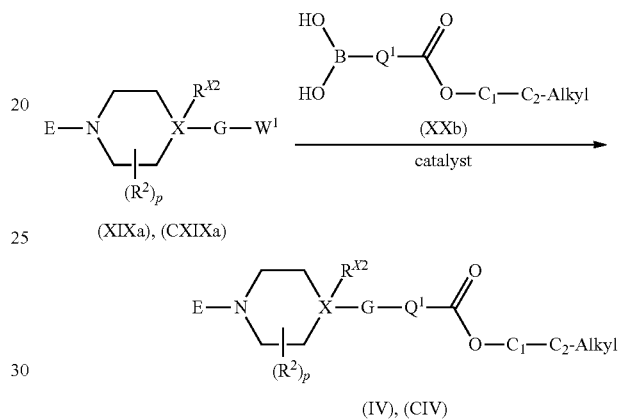
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mides) XIXa or (CXIXa). Numerous catalysts can be used for this reaction, typically tetrakis(triphenylphosphine)palladium(0). The solvents used may, for example, be tetrahydrofuran, acetonitrile, diethyl ether and dioxane.

There are numerous literature examples of the Suzuki reaction and related coupling reactions formation of the G-Q¹ bond (see, for example, Tetrahedron, 2004, 60, 8991-9016; Palladium in *Heterocyclic Chemistry: A Guide for the Synthetic Chemist*, J. J. Li, G. W. Gribble, Elsevier, Oxford, 2000).

Process R

Scheme 18: Process R

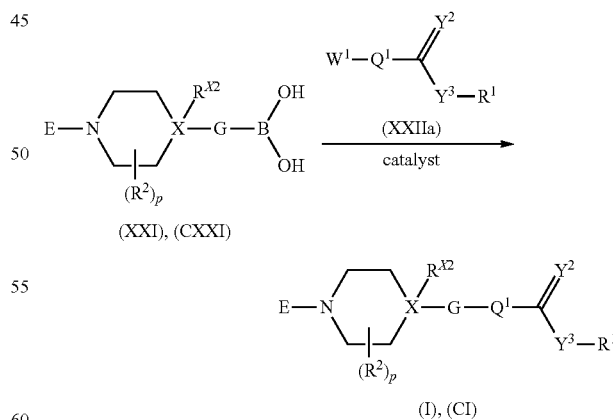


One means of preparing compounds of the formula (IV) and (CIV) from corresponding compounds (XIXa) and (CXIXa) is shown in Scheme 18.

The same process as already described in Scheme 17 (process Q) is used.

Process S

Scheme 19: Process S



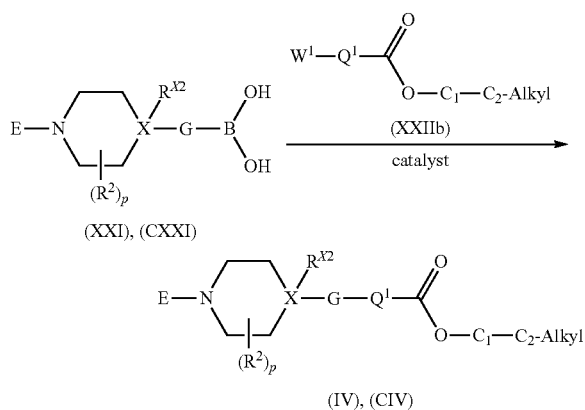
One means of preparing compounds of the formula (I) and (CI) from corresponding compounds (XXI) and (CXXI) is shown in Scheme 19.

The same process as already described in Scheme 18 (process R) is used.

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Process T

Scheme 20: Process T

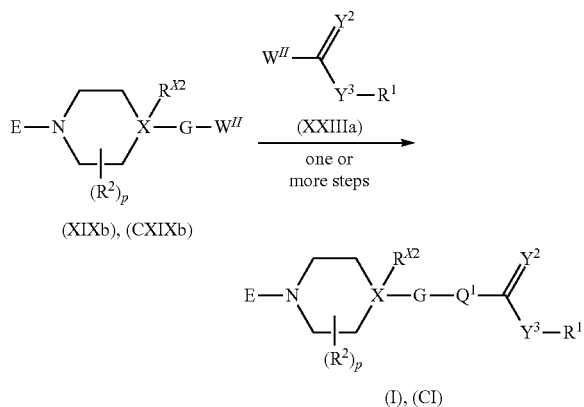


One means of preparing compounds of the formula (IV) and (CIV) from corresponding compounds (XXI) and (CXXI) is shown in Scheme 20.

The same process as already described in Scheme 18 (process R) is used.

Process U

Scheme 21: Process U



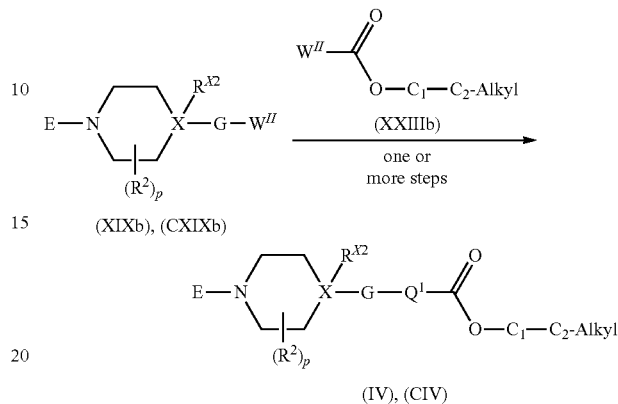
In general, it is possible to prepare compounds of the formula (I) and (CI) from corresponding compounds (XIXb) or (CXIXb) and (XXIIIa) with suitable functional groups, W^{II} and W^{III} (see Scheme 21, process U). The possible functional groups for W^{II} and W^{III} are, for example, aldehydes, ketones, esters, carboxylic acids, amides, thioamides, nitriles, amines, alcohols, thiols, hydrazines, oximes, amidines, amide oximes, olefins, acetylenes, halides, alkyl halides, methane-sulphonates, trifluoromethanesulphonates, boronic acids, boronates etc., which can form the desired heterocycles Q^1 under suitable reaction conditions. There are numerous literature methods for the preparation of heterocycles (see, for example, WO2008/013622; WO2008/013925; *Comprehensive Heterocyclic Chemistry Vol. 4-6*, A. R. Katritzky and C. W. Rees editors, Pergamon Press, New York, 1984; *Comprehensive Heterocyclic Chemistry II*, Vol 2-4, A. R. Katritzky, C. W. Rees and E. F. Scriven editors, Pergamon Press, New York, 1996; *The Chemistry of Heterocyclic Compounds*, E. C. Taylor, editor, Wiley, New York; *Rodd's Chemistry of Carbon*

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Compounds, Vol. 2-4, Elsevier, New York; *Synthesis*, 1982, 6, 508-509; *Tetrahedron*, 2000, 56, 1057-1094).

Process V

Scheme 22: Process V

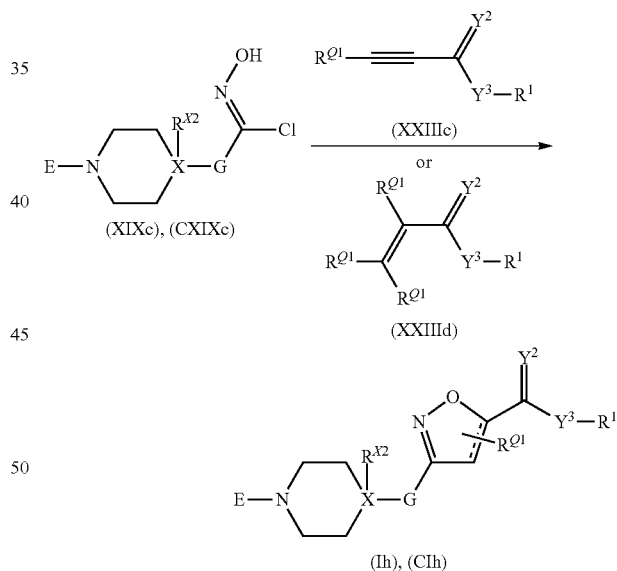


One means of preparing compounds of the formula (IV) and (CIV) from corresponding compounds (XIXb) and (CXIXb) is shown in Scheme 22.

The same process as already described in Scheme 21 (process U) is used.

Process W

Scheme 23: Process W



Scheme 23 shows that, for example, isoxazoles and isoxazolines of the formula (Ih) and (CIh) can be prepared from corresponding chloroximes (XIXc) or (CXIXc) and the compounds (XXIIIc) or (XXIIId).

The alkenes and alkynes (XXIIIc) and (XXIIId) are commercially available or can be prepared from commercially available precursors by methods described in the literature (see, for example, *Hydrocarbon Processing*, 1986, 65, 37-43; *Science of Synthesis*, Volume 43, Thieme, 2008; *Science of Synthesis*, Volume 47 a & b, Thieme, 2008).

Compounds of the general formula (Ih) and (CIh) are obtained from an alkene of the general formula (XXIIId) or

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from an alkyne of the formula (XXIIIc) and compound (XIXc) or (CXIXc) by a cycloaddition reaction (see, for example, WO2008/013622 and *Synthesis*, 1987, 11, 998-1001).

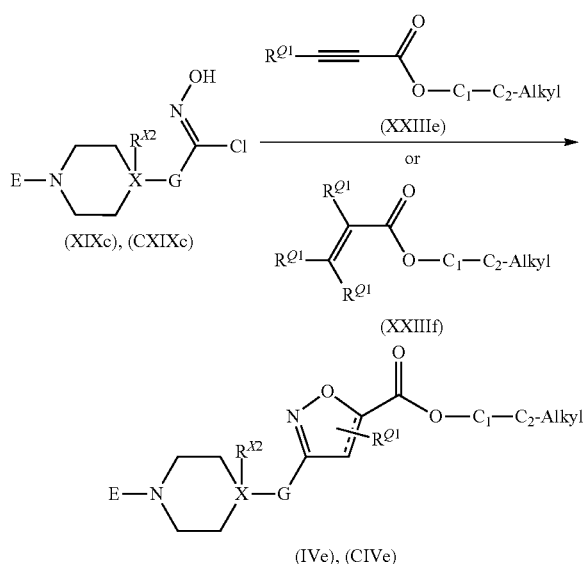
Process W is performed in the presence of a suitable base. Preferred bases are tertiary amines (e.g. triethylamine), and alkali metal or alkaline earth metal carbonates, hydrogencarbonates and phosphates.

Process W is preferably performed using one or more diluents. In the performance of process W, inert organic solvents are a preferred option (for example toluene and hexane). Water is likewise a possible solvent. Alternatively, process W can be performed in an excess of the alkene (XXIIIId) or of the alkyne (XXIIIc).

The workup is effected by customary methods. If necessary, the compounds are purified by recrystallization, distillation or chromatography, or can optionally also be used in the next step without prior purification.

Process X

Scheme 24: Process X

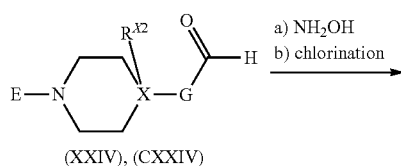


One means of preparing compounds of the formula (IVe) and (CIVe) from corresponding compounds (XIXc) and (CXIXc) is shown in Scheme 24.

The same process as already described in Scheme 23 (process W) is used.

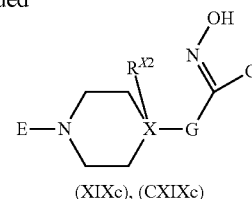
Process Y

Scheme 25: Process Y



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-continued



One means of preparing the intermediates (XIXc) and (CXIXc) from (XXIV) and (CXXIV) is shown in Scheme 25 (process Y).

Some of the compounds of the formula (XXIV) and (CXXIV) are known from the literature and can be prepared by known methods (see, for example, WO2008/013622; WO2008/013925).

Compounds of the general formula (XIXc) and (CXIXc) are obtained by condensation of an aldehyde of the formula (XXIV) or (CXXIV) with hydroxylamine and subsequent chlorination (see, for example, WO2005/0040159, WO2008/013622 and *Synthesis*, 1987, 11, 998-1001).

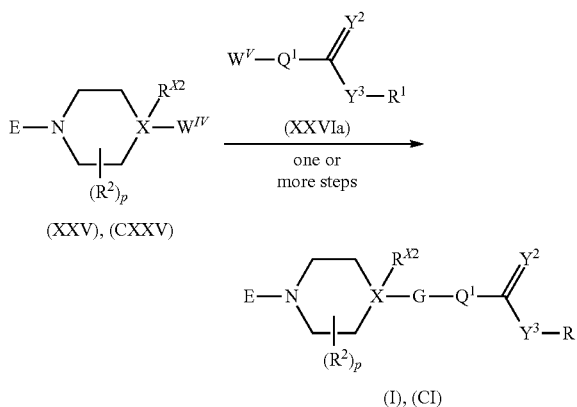
In process Y, aldehyde (XXIV) or (CXXIV) and hydroxylamine are first reacted (step a). The corresponding oxime is subsequently chlorinated in the presence of a suitable chlorinating agent. Preferred chlorinating reagents are N-chlorosuccinimide, HClO, NaClO and chlorine. After step (a) of process Y, the reaction mixture can be worked up by customary methods or converted further directly in step (b).

Process Y is preferably performed using one or more diluents. In step (a) of process Y according to the invention, preference is given to using protic solvents, for example ethanol, as the solvent. After the formation of the corresponding oxime from compound (XXIV) or (CXXIV), the reaction mixture is diluted in step (b) with a further solvent, for example tetrahydrofuran, and then aqueous sodium hypochlorite is added. The chlorination can likewise be effected with the aid of N-chlorosuccinimide in DMF.

The workup is effected by customary methods. If necessary, the compounds are purified by recrystallization or chromatography, or can optionally also be used in the next step without prior purification.

Process Z

Scheme 26: Process Z

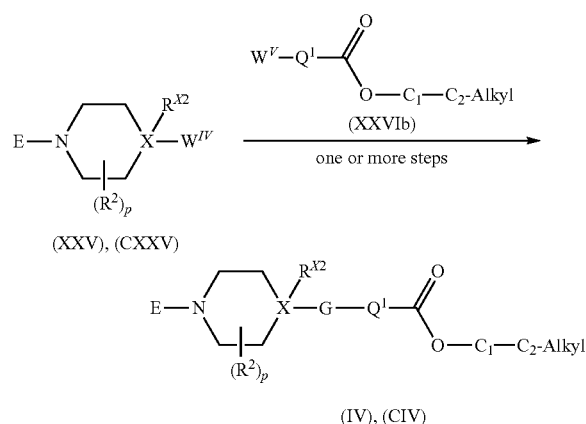


In general, it is possible to prepare the intermediates of the formula (I) and (CI) from corresponding compounds (XXV) or (CXXV) and (XXVIa) with suitable functional groups,

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W^{IV} and W^V (see Scheme 26, process Z). The possible functional groups for W^{IV} and W^V are, for example, aldehydes, ketones, esters, carboxylic acids, amides, thioamides, nitriles, alcohols, thiols, hydrazines, oximes, amidines, amide oxides, olefins, acetylenes, halides, alkyl halides, methanesulphonates, trifluoromethanesulphonates, boric acid, boronates etc. They can form the desired 5-membered heterocycle G under suitable reaction conditions. There are numerous literature methods for the preparation of heterocycles (see WO2008/013622; *Comprehensive Heterocyclic Chemistry* Vol. 4-6, A. R. Katritzky and C. W. Rees editors, Pergamon Press, New York, 1984; *Comprehensive Heterocyclic Chemistry II*, Vol 2-4, A. R. Katritzky, C. W. Rees and E. F. Scriven editors, Pergamon Press, New York, 1996; *The Chemistry of Heterocyclic Compounds*, E. C. Taylor, editor, Wiley, New York).

Scheme 27: Process AA

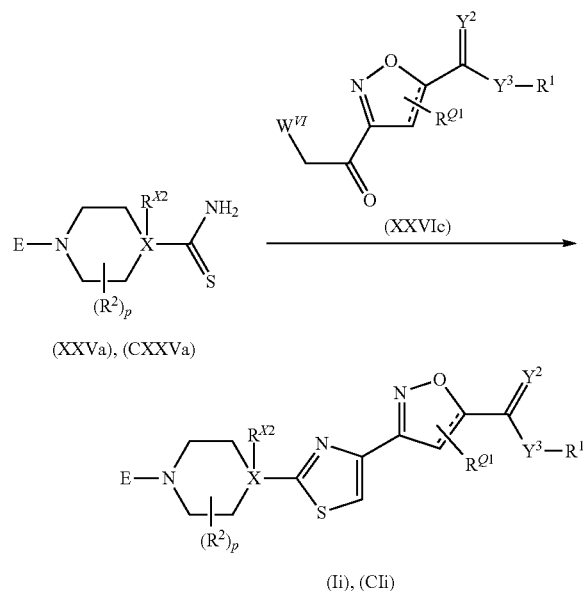


One means of preparing compounds of the formula (IV) and (CIV) from corresponding compounds (XXV) and (CXXV) is shown in Scheme 27.

The same process as already described in Scheme 26 (process Z) is used.

Process AB

Scheme 28: Process AB



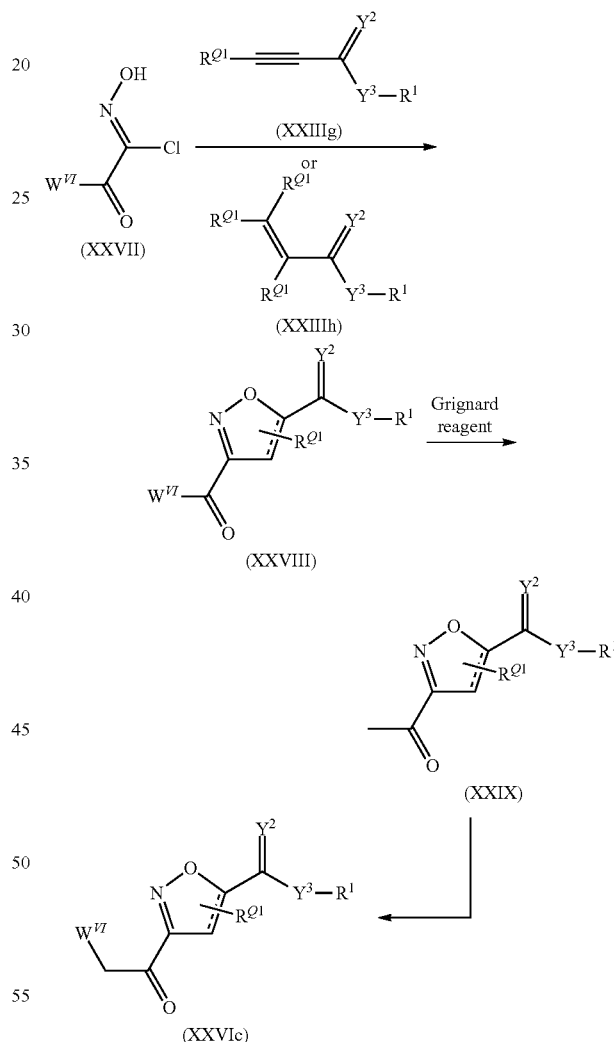
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A particular means of synthesizing compounds of the formula (Ii) and (CII) from compounds (XXVa) and (CXXVa) with the compounds (XXVIc) is shown in Scheme 28 (process AB). When E is A-L¹(Y¹), the compounds are those of the formula (XXVa) or (Ii). When E is acetyl, C₁-C₄-alkoxycarbonyl, benzyl or benzyloxycarbonyl, the compounds are those of the formula (CXXVa) or (CII).

Thiocarboxamides (XXVa) and (CXXVa) are obtainable by methods known from the literature, for example by thionating the commercially available corresponding carboxamide by using, for example, Lawesson's reagent (WO2008/013622, *Org. Synth.* Vol. 7, 1990, 372).

α -Halo ketones (XXVIIc) or corresponding equivalents (e.g. toluenesulphonyloxy) are also obtainable by methods known from the literature (for examples see WO2008/013622), (FIG. 3).

Figure 3:



W^{VII} is N,N-dimethylamino, N-methoxy-N-methylamino or morpholin-1-yl.

The thiazoles (I) are obtained by a Hantzsch thiazole synthesis from the thiocarboxamides (XXVa) or (CXXVa) and α -halo ketones or corresponding equivalents (XXVIc) (see, for example, "Comprehensive Heterocyclic Chemistry", Pergamon Press, 1984; vol. 6, pages 235-363, "Comprehensive Heterocyclic Chemistry II", Pergamon Press, 1996; vol. 3, pages 373-474, and WO 07/014,290).

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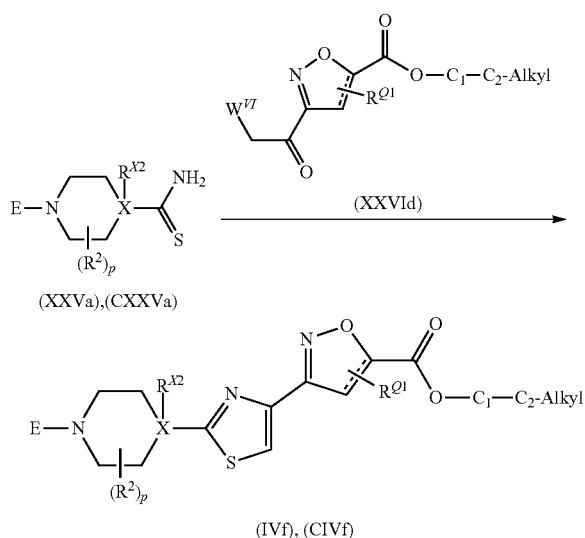
Process AB is preferably performed using one or more diluents. In the performance of process AB, inert organic solvents are a preferred option (for example N,N-dimethylformamide and ethanol).

An auxiliary base is optionally used, for example triethylamine.

If necessary, the compounds are purified by recrystallization or chromatography, or can optionally also be used in the next step without prior purification.

Process AC

Scheme 29: Process AC

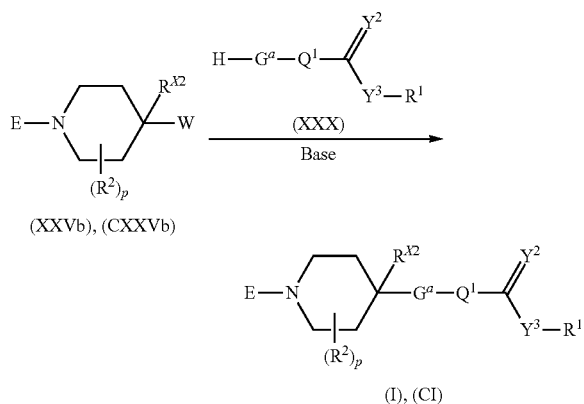


One means of preparing compounds of the formula (IVf) and (CIVf) from corresponding compounds (XXVa) and (CXXVa) is shown in Scheme 29.

The same process as already described in Scheme 28 (process AB) is used.

Process AD

Scheme 30: Process AD



A compound with the general formula (I) and (CI) can be synthesized analogously to methods described in the literature by a coupling reaction of a compound with the corresponding general formula (XXVb) or (CXXVb) with a substrate of the general formula (XXX), optionally in the

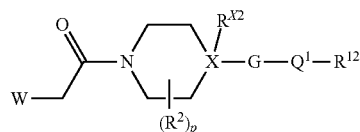
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presence of a base (Scheme 30, process AD) (see, for example, for Zn/Pd coupling: WO2008/147831, WO 2006/106423 (pyridine), Shakespeare, W. C. et al. *Chem. Biol. Drug Design* 2008, 71, 97-105 (pyrimidine derivatives), Pasternak, A. et al. *Bioorg. Med. Chem. Lett.* 2008, 18, 994-998 (diazines); Coleridge, B. M.; Bello, C. S.; Leitner, A. *Tetrahedron Lett.* 2009, 50, 4475-4477; Bach, T., Heuser, S. *Angew. Chem. Int. Ed.* 2001, 40, 3184-3185. (thiazoles); for nucleophilic substitutions: WO2008/104077; WO2006/084015 (pyrazoles with N-substitution).

At least one equivalent of a base (e.g. sodium hydride, potassium carbonate) is used in relation to the starting material of the general formula (XXX).

After the reaction has ended, the compounds (I) and (CI) are separated from the reaction mixture by one of the customary separation techniques. If necessary, the compounds are purified by recrystallization or chromatography, or can, if desired, also be used in the next step without prior purification.

Novel compounds are those of the formula (XXXI)



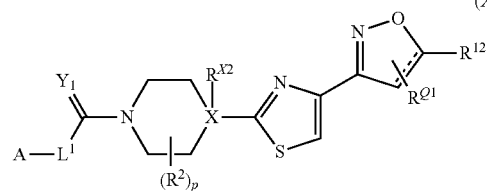
W is a leaving group

R¹² is -C(=Y²)-Y³-R¹ or -C(=O)-C₁₋₂-alkyl,

and salts metal complexes and N-oxides thereof, in which the symbols Y², Y³, Q¹, G, R¹², R² and R¹ have the above-specified general, preferred, more preferred or most preferred definitions.

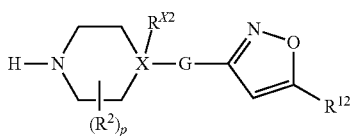
Preferred compounds (XXXI) are those in which W is chlorine, bromine, iodine, methanesulphonyloxy or toluenesulphonyloxy. Particularly preferred compounds (XXXI) are those in which W is chlorine.

Novel compounds are those of the formula (XXXII)



and salts metal complexes and N-oxides thereof, in which the symbols Y², Y³, R², R¹², R^{Q1} and R¹ have the above-specified general, preferred, more preferred or most preferred definitions.

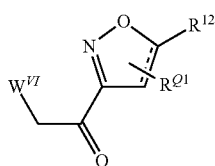
Novel compounds are those of the formula (XXXIII)



and salts, metal complexes and N-oxides thereof, in which the symbols X, R², R¹², G, R¹, Y² and Y³ have the above-specified general, preferred, more preferred or most preferred definitions.

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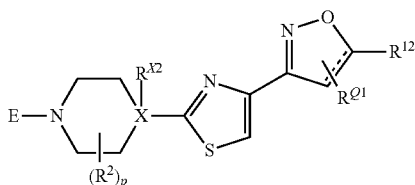
Novel compounds are those of the formula (XXXIV)



(XXXIV)

R^{12} is $-\text{C}(=\text{Y}^2)\text{Y}^3-\text{R}^1$ or $-\text{C}(=\text{O})\text{O}-(\text{C}_1-\text{C}_2\text{-alkyl})$, W^{17} is chlorine, bromine, iodine, toluenesulphonyloxy or methanesulphonyloxy, and salts, metal complexes and N-oxides thereof, in which the symbols Y^2 , Y^3 , $\text{R}^{\text{Q}1}$ and R^1 have the above-specified general, preferred, more preferred or most preferred definitions.

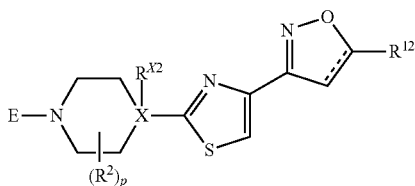
Novel compounds are those of the formula (XXXV)



(XXXV)

and salts, metal complexes and N-oxides thereof, in which the symbols A, L^1 , Y^1 , R^2 , $\text{R}^{\text{X}2}$ and $\text{R}^{\text{Q}1}$ have the above-specified general, preferred, more preferred or most preferred definitions.

Novel compounds are those of the formula (XXXVI)

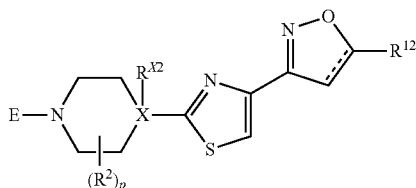


(XXXVI)

under the condition that E must not be [5-methyl-3-(trifluoromethyl)-1H-pyrazol-1-yl]ethanoyl when R^{12} is $-\text{C}(=\text{O})\text{OMe}$,

and salts, metal complexes and N-oxides thereof, in which the symbols A, L^1 , Y^1 and $\text{R}^{\text{X}2}$ have the above-specified general, preferred, more preferred or most preferred definitions.

Novel compounds are those of the formula (XXXVII)

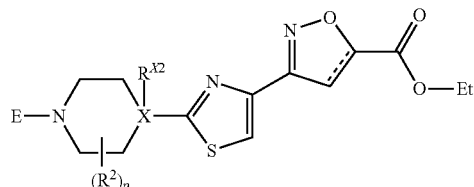


(XXXVII)

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under the condition that E is [3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]ethanoyl when R^{12} is $-\text{C}(=\text{O})\text{OMe}$, and salts, metal complexes and N-oxides thereof, in which the symbols R^2 and $\text{R}^{\text{X}2}$ have the above-specified general, preferred, more preferred or most preferred definitions.

Novel compounds are those of the formula (XXXVIII)



(XXXVIII)

and salts, metal complexes and N-oxides thereof, in which the symbols R^2 and $\text{R}^{\text{X}2}$ have the above-specified general, preferred, more preferred or most preferred definitions.

The present invention further provides for the use of at least one compound of the formula (XXXI), (XXXII), (XXXIV), (XXXV), (XXXVI), (XXXVII) and/or (XXXVIII) for preparation of a compound of the formula (I).

The invention further provides for the non-medical use of the inventive heteroarylpiperidine and -piperazine derivatives of the formula (I) for control of unwanted microorganisms.

The invention further provides a composition for controlling unwanted microorganisms, comprising at least one heteroarylpiperidine and -piperazine derivative according to the present invention.

The invention also relates to a method for controlling unwanted microorganisms, characterized in that the inventive heteroarylpiperidine and -piperazine derivatives are applied to the microorganisms and/or in their habitat.

The invention further relates to seed which has been treated with at least one inventive heteroarylpiperidine and -piperazine derivative.

The invention finally provides a method for protecting seed against unwanted microorganisms by using seed treated with at least one heteroarylpiperidine and -piperazine derivative according to the present invention.

The inventive substances have potent microbicidal activity and can be used for control of unwanted microorganisms, such as fungi and bacteria, in crop protection and in the protection of materials.

The inventive heteroarylpiperidine and -piperazine derivatives of the formula (I) have very good fungicidal properties and can be used in crop protection, for example for control of Plasmodiophoromycetes, Oomycetes, Chytridiomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.

Bactericides can be used in crop protection, for example, for control of Pseudomonadaceae, Rhizobiaceae, Enterobacteriaceae, Corynebacteriaceae and Streptomycetaceae.

The inventive fungicidal compositions can be used for curative or protective control of phytopathogenic fungi. The invention therefore also relates to curative and protective methods for controlling phytopathogenic fungi by the use of the inventive active ingredients or compositions, which are applied to the seed, the plant or plant parts, the fruit or the soil in which the plants grow.

The inventive compositions for controlling phytopathogenic fungi in crop protection comprise an effective but non-phytotoxic amount of the inventive active ingredients. An

“effective but non-phytotoxic amount” means an amount of the inventive composition which is sufficient to control the fungal disease of the plant in a satisfactory manner or to eradicate the fungal disease completely, and which, at the same time, does not cause any significant symptoms of phytotoxicity. In general, this application rate may vary within a relatively wide range. It depends on several factors, for example on the fungus to be controlled, the plant, the climatic conditions and the ingredients of the inventive compositions.

All plants and plant parts can be treated in accordance with the invention. Plants are understood here to mean all plants and plant populations, such as desired and undesired wild plants or crop plants (including naturally occurring crop plants). Crop plants may be plants which can be obtained by conventional breeding and optimization methods or by biotechnological and genetic engineering methods or combinations of these methods, including the transgenic plants and including the plant cultivars which are protectable and non-protectable by plant breeders’ rights. Plant parts are understood to mean all parts and organs of plants above and below the ground, such as shoot, leaf, flower and root, examples of which include leaves, needles, stalks, stems, flowers, fruit bodies, fruits, seeds, roots, tubers and rhizomes. The plant parts also include harvested material and vegetative and generative propagation material, for example cuttings, tubers, rhizomes, slips and seeds.

Plants which can be treated in accordance with the invention include the following: cotton, flax, grapevine, fruit, vegetables, such as *Rosaceae* sp. (for example pome fruits such as apples and pears, but also stone fruits such as apricots, cherries, almonds and peaches, and soft fruits such as strawberries), *Ribesioideae* sp., *Juglandaceae* sp., *Betulaceae* sp., *Anacardiaceae* sp., *Fagaceae* sp., *Moraceae* sp., *Oleaceae* sp., *Actinidaceae* sp., *Lauraceae* sp., *Musaceae* sp. (for example banana trees and plantations), *Rubiaceae* sp. (for example coffee), *Theaceae* sp., *Sterculiaceae* sp., *Rutaceae* sp. (for example lemons, oranges and grapefruit); *Solanaceae* sp. (for example tomatoes), *Liliaceae* sp., *Asteraceae* sp. (for example lettuce), *Umbelliferae* sp., *Cruciferae* sp., *Chenopodiaceae* sp., *Cucurbitaceae* sp. (for example cucumber), *Alliaceae* sp. (for example leek, onion), *Papilionaceae* sp. (for example peas); major crop plants, such as *Gramineae* sp. (for example maize, turf, cereals such as wheat, rye, rice, barley, oats, millet and triticale), *Asteraceae* sp. (for example sunflower), *Brassicaceae* sp. (for example white cabbage, red cabbage, broccoli, cauliflower, Brussels sprouts, pak choi, kohlrabi, radishes, and oilseed rape, mustard, horseradish and cress), *Fabaceae* sp. (for example bean, peanuts), *Papilionaceae* sp. (for example soya bean), *Solanaceae* sp. (for example potatoes), *Chenopodiaceae* sp. (for example sugar beet, fodder beet, swiss chard, beetroot); useful plants and ornamental plants; and genetically modified varieties of each of these plants.

Non-limiting examples of pathogens of fungal diseases which can be treated in accordance with the invention include:

diseases caused by powdery mildew pathogens, for example *Blumeria* species, for example *Blumeria graminis*; *Podosphaera* species, for example *Podosphaera leucotricha*; *Sphaerotheca* species, for example *Sphaerotheca fuliginea*; *Uncinula* species, for example *Uncinula necator*;

diseases caused by rust disease pathogens, for example *Gymnosporangium* species, for example *Gymnosporangium sabinae*; *Hemileia* species, for example *Hemileia vastatrix*; *Phakopsora* species, for example *Phakopsora pachyrhizi* or *Phakopsora meibomia*; *Puccinia* species,

for example *Puccinia recondita*, *Puccinia graminis* or *Puccinia striiformis*; *Uromyces* species, for example *Uromyces appendiculatus*;

diseases caused by pathogens from the group of the Oomycetes, for example *Albugo* species, for example *Albugo candida*; *Bremia* species, for example *Bremia lactucae*; *Peronospora* species, for example *Peronospora pisi* or *P. brassicae*; *Phytophthora* species, for example *Phytophthora infestans*; *Plasmopara* species, for example *Plasmopara viticola*; *Pseudoperonospora* species, for example *Pseudoperonospora humuli* or *Pseudoperonospora cubensis*; *Pythium* species, for example *Pythium ultimum*;

leaf blotch diseases and leaf wilt diseases caused, for example, by *Alternaria* species, for example *Alternaria solani*; *Cercospora* species, for example *Cercospora beticola*; *Cladosporium* species, for example *Cladosporium cucumerinum*; *Cochliobolus* species, for example *Cochliobolus sativus* (conidial form: *Drechslera*, syn: *Helminthosporium*) or *Cochliobolus miyabeanus*; *Colletotrichum* species, for example *Colletotrichum lindemuthianum*; *Cycloconium* species, for example *Cycloconium oleaginum*; *Diaporthe* species, for example *Diaporthe citri*; *Elsinoe* species, for example *Elsinoe fawcettii*; *Gloeosporium* species, for example *Gloeosporium laeticolor*; *Glomerella* species, for example *Glomerella cingulata*; *Guignardia* species, for example *Guignardia bidwelli*; *Leptosphaeria* species, for example *Leptosphaeria maculans*; *Magnaporthe* species, for example *Magnaporthe grisea*; *Microdochium* species, for example *Microdochium nivale*; *Mycosphaerella* species, for example *Mycosphaerella graminicola*, *Mycosphaerella arachidicola* or *Mycosphaerella fijiensis*; *Phaeosphaeria* species, for example *Phaeosphaeria nodorum*; *Pyrenophora* species, for example *Pyrenophora teres* or *Pyrenophora tritici repentis*; *Ramularia* species, for example *Ramularia collo-cygni* or *Ramularia areola*; *Rhynchosporium* species, for example *Rhynchosporium secalis*; *Septoria* species, for example *Septoria apii* or *Septoria lycopersici*; *Stagonospora* species, for example *Stagonospora nodorum*; *Typhula* species, for example *Typhula incarnata*; *Venturia* species, for example *Venturia inaequalis*;

root and stem diseases caused, for example, by *Corticium* species, for example *Corticium graminearum*; *Fusarium* species, for example *Fusarium oxysporum*; *Gaeumannomyces* species, for example *Gaeumannomyces graminis*; *Plasmodiophora* species, for example *Plasmodiophora brassicae*; *Rhizoctonia* species, for example *Rhizoctonia solani*; *Sarocladium* species, for example *Sarocladium oryzae*; *Sclerotium* species, for example *Sclerotium oryzae*; *Tapesia* species, for example *Tapesia acuformis*; *Thielaviopsis* species, for example *Thielaviopsis basicola*;

ear and panicle diseases (including corn cobs) caused, for example, by *Alternaria* species, for example *Alternaria* spp.; *Aspergillus* species, for example *Aspergillus flavus*; *Cladosporium* species, for example *Cladosporium cladosporioides*; *Claviceps* species, for example *Claviceps purpurea*; *Fusarium* species, for example *Fusarium culmorum*; *Gibberella* species, for example *Gibberella zeae*; *Monographella* species, for example *Monographella nivalis*; *Stagonospora* species, for example *Stagonospora nodorum*;

diseases caused by smut fungi, for example *Sphacelotheca* species, for example *Sphacelotheca reiliana*; *Tilletia* species, for example *Tilletia caries* or *Tilletia controversa*; *Urocystis* species, for example *Urocystis occulta*; *Ustilago* species, for example *Ustilago nuda*;

fruit rot caused, for example, by *Aspergillus* species, for example *Aspergillus flavus*; *Botrytis* species, for example *Botrytis cinerea*; *Penicillium* species, for example *Penicillium expansum* or *Penicillium purpurogenum*; *Rhizopus* species, for example *Rhizopus stolonifer*; *Sclerotinia* species, for example *Sclerotinia sclerotiorum*; *Verticillium* species, for example *Verticillium albo-atrum*;

seed- and soil-borne rot and wilt diseases, and also diseases of seedlings, caused, for example, by *Alternaria* species, for example *Alternaria brassicicola*; *Aphanomyces* species, for example *Aphanomyces euteiches*; *Ascochyta* species, for example *Ascochyta lentis*; *Aspergillus* species, for example *Aspergillus flavus*; *Cladosporium* species, for example *Cladosporium herbarum*; *Cochliobolus* species, for example *Cochliobolus sativus* (conidial form: *Drechslera*, *Bipolaris* syn: *Helminthosporium*); *Colletotrichum* species, for example *Colletotrichum coccodes*; *Fusarium* species, for example *Fusarium culmorum*; *Gibberella* species, for example *Gibberella zeae*; *Macrophomina* species, for example *Macrophomina phaseolina*; *Microdochium* species, for example *Microdochium nivale*; *Monographella* species, for example *Monographella nivalis*; *Penicillium* species, for example *Penicillium expansum*; *Phoma* species, for example *Phoma lingam*; *Phomopsis* species, for example *Phomopsis sojae*; *Phytophthora* species, for example *Phytophthora cactorum*; *Pyrenophora* species, for example *Pyrenophora graminea*; *Pyricularia* species, for example *Pyricularia oryzae*; *Pythium* species, for example *Pythium ultimum*; *Rhizoctonia* species, for example *Rhizoctonia solani*; *Rhizopus* species, for example *Rhizopus oryzae*; *Sclerotium* species, for example *Sclerotium rolfsii*; *Septoria* species, for example *Septoria nodorum*; *Typhula* species, for example *Typhula incarnata*; *Verticillium* species, for example *Verticillium dahliae*;

cancers, galls and witches' broom caused, for example, by *Nectria* species, for example *Nectria galligena*; wilt diseases caused, for example, by *Monilinia* species, for example *Monilinia laxa*;

deformations of leaves, flowers and fruits caused, for example, by *Exobasidium* species, for example *Exobasidium vexans*; *Taphrina* species, for example *Taphrina deformans*;

degenerative diseases in woody plants, caused, for example, by *Esca* species, for example *Phaeomoniella chlamydospora*, *Phaeoacremonium aleophilum* or *Fomitiporia mediterranea*; *Ganoderma* species, for example *Ganoderma boninense*;

diseases of flowers and seeds caused, for example, by *Botrytis* species, for example *Botrytis cinerea*;

diseases of plant tubers caused, for example, by *Rhizoctonia* species, for example *Rhizoctonia solani*; *Helminthosporium* species, for example *Helminthosporium solani*;

diseases caused by bacterial pathogens, for example *Xanthomonas* species, for example *Xanthomonas campestris* pv. *oryzae*; *Pseudomonas* species, for example *Pseudomonas syringae* pv. *lachrymans*; *Erwinia* species, for example *Erwinia amylovora*.

The following diseases of soya beans can be controlled with preference:

Fungal diseases on leaves, stems, pods and seeds caused, for example, by *Alternaria* leaf spot (*Alternaria* spec. *atrans tenuissima*), Anthracnose (*Colletotrichum gloeosporoides dematium* var. *truncatum*), brown spot (*Septoria glycines*), *cercospora* leaf spot and blight (*Cercospora kikuchii*), *choanephora* leaf blight (*Choanephora infundibulifera trispora* (Syn.)), *dactuliophora* leaf spot (*Dactuliophora*

glycines), downy mildew (*Peronospora manshurica*), *drechslera* blight (*Drechslera glycini*), frog-eye leaf spot (*Cercospora sojae*), *leptosphaerulina* leaf spot (*Leptosphaerulina trifolii*), *phyllostica* leaf spot (*Phyllosticta sojaecola*), pod and stem blight (*Phomopsis sojae*), powdery mildew (*Microsphaera diffusa*), *pyrenochaeta* leaf spot (*Pyrenochaeta glycines*), *rhizoctonia* aerial, foliage, and web blight (*Rhizoctonia solani*), rust (*Phakopsora pachyrhizi*, *Phakopsora meibomia*), scab (*Sphaceloma glycines*), *stemphylium* leaf blight (*Stemphylium botryosum*), target spot (*Corynespora cassiicola*).

Fungal diseases on roots and the stem base caused, for example, by black root rot (*Calonectria crotalariae*), charcoal rot (*Macrophomina phaseolina*), *fusarium* blight or wilt, root rot, and pod and collar rot (*Fusarium oxysporum*, *Fusarium orthoceras*, *Fusarium semitectum*, *Fusarium equiseti*), *mycoleptodiscus* root rot (*Mycoleptodiscus terrestris*), *neocosmospora* (*Neocosmospora vasinfecta*), pod and stem blight (*Diaporthe phaseolorum*), stem canker (*Diaporthe phaseolorum* var. *caulivora*), *phytophthora* rot (*Phytophthora megasperma*), brown stem rot (*Phialophora gregata*), *pythium* rot (*Pythium aphanidermatum*, *Pythium irregulare*, *Pythium debaryanum*, *Pythium myriotylum*, *Pythium ultimum*), *rhizoctonia* root rot, stem decay, and damping-off (*Rhizoctonia solani*), *sclerotinia* stem decay (*Sclerotinia sclerotiorum*), *sclerotinia* southern blight (*Sclerotinia rolfsii*), *thielaviopsis* root rot (*Thielaviopsis basicola*).

The inventive active ingredients also have very good fortifying action in plants. They are therefore suitable for mobilizing the plant's own defences against attack by undesirable microorganisms.

Plant-fortifying (resistance-inducing) substances are understood to mean, in the present context, those substances which are capable of stimulating the defence system of plants in such a way that the treated plants, when subsequently inoculated with undesirable microorganisms, develop a high degree of resistance to these microorganisms.

In the present case, undesirable microorganisms are understood to mean phytopathogenic fungi and bacteria. The inventive substances can thus be used to protect plants for a certain period after the treatment against attack by the pathogens mentioned. The period for which protection is provided generally extends over 1 to 10 days, preferably 1 to 7 days, after the treatment of the plants with the active ingredients.

The fact that the active ingredients are well tolerated by plants at the concentrations required for controlling plant diseases allows the treatment of above-ground parts of plants, of propagation stock and seeds, and of the soil.

The inventive active ingredients can be used particularly successfully to control diseases in viticulture and potato, fruit and vegetable growing, for example particularly against powdery mildew fungi, Oomycetes, for example *Phytophthora*, *Plasmopara*, *Pseudoperonospora* and *Pythium* species.

The inventive active ingredients are also suitable for enhancing the yield of crops. In addition, they have low toxicity and are well tolerated by plants.

In some cases, the inventive compounds can, at particular concentrations or application rates, also be used as herbicides, safeners, growth regulators or compositions to improve plant properties, or as microbicides, for example as fungicides, antimycotics, bactericides, viricides (including compositions against viroids) or as compositions against MLO (Mycoplasma-like organisms) and RLQ (*Rickettsia*-like organisms). If appropriate, they can also be used as insecticides. If appropriate, they can also be used as intermediates or precursors for the synthesis of other active ingredients.

The inventive active ingredients, when they are well tolerated by plants, have favourable homeotherm toxicity and are well tolerated by the environment, are suitable for protecting plants and plant organs, for enhancing harvest yields, for improving the quality of the harvested material in agriculture, in horticulture, in animal husbandry, in forests, in gardens and leisure facilities, in the protection of stored products and of materials, and in the hygiene sector. They can preferably be used as crop protection agents. They are effective against normally sensitive and resistant species and against all or some stages of development.

The inventive treatment of the plants and plant parts with the active ingredients or compositions is effected directly or by action on their surroundings, habitat or storage space by the customary treatment methods, for example by dipping, spraying, atomizing, irrigating, evaporating, dusting, fogging, broadcasting, foaming, painting, spreading-on, watering (drenching), drip irrigating and, in the case of propagation material, especially in the case of seeds, also by dry seed treatment, wet seed treatment, slurry seed treatment, incrustation, coating with one or more coats, etc. It is also possible to deploy the active ingredients by the ultra-low volume method or to inject the active ingredient preparation or the active ingredient itself into the soil.

The inventive active ingredients or compositions can also be used in the protection of materials, for protecting industrial materials against attack and destruction by unwanted microorganisms, for example fungi.

Industrial materials in the present context are understood as meaning non-living materials which have been prepared for use in industry. For example, industrial materials which are to be protected by inventive active ingredients from microbial alteration or destruction may be adhesives, sizes, paper and board, textiles, leather, wood, paints and plastic articles, cooling lubricants and other materials which can be infected with or destroyed by microorganisms. The range of materials to be protected also includes parts of production plants, for example cooling water circuits, which may be impaired by the proliferation of microorganisms. Industrial materials within the scope of the present invention preferably include adhesives, sizes, paper and cardboard, leather, wood, paints, cooling lubricants and heat transfer fluids, more preferably wood. The inventive active ingredients or compositions may prevent adverse effects, such as rotting, decay, discoloration, decoloration or formation of mould.

The inventive method for controlling unwanted fungi can also be employed for protecting storage goods. Storage goods are understood to mean natural substances of vegetable or animal origin or processed products thereof which are of natural origin, and for which long-term protection is desired. Storage goods of vegetable origin, for example plants or plant parts, such as stems, leaves, tubers, seeds, fruits, grains, can be protected freshly harvested or after processing by (pre) drying, moistening, comminuting, grinding, pressing or roasting. Storage goods also include timber, both unprocessed, such as construction timber, electricity poles and barriers, or in the form of finished products, such as furniture. Storage goods of animal origin are, for example, hides, leather, furs and hairs. The inventive active ingredients may prevent adverse effects, such as rotting, decay, discoloration, decoloration or formation of mould.

Microorganisms capable of degrading or altering the industrial materials include, for example, bacteria, fungi, yeasts, algae and slime organisms. The inventive active ingredients preferably act against fungi, especially moulds, wood-discoloring and wood-destroying fungi (Basidiomycetes), and against slime organisms and algae. Examples include

microorganisms of the following genera: *Alternaria*, such as *Alternaria tenuis*; *Aspergillus*, such as *Aspergillus niger*; *Chaetomium*, such as *Chaetomium globosum*; *Coniophora*, such as *Coniophora puetana*; *Lentinus*, such as *Lentinus tigrinus*; *Penicillium*, such as *Penicillium glaucum*; *Polyporus*, such as *Polyporus versicolor*; *Aureobasidium*, such as *Aureobasidium pullulans*; *Sclerophoma*, such as *Sclerophoma pityophila*; *Trichoderma*, such as *Trichoderma viride*; *Escherichia*, such as *Escherichia coli*; *Pseudomonas*, such as *Pseudomonas aeruginosa*; *Staphylococcus*, such as *Staphylococcus aureus*.

The present invention further relates to a composition for controlling unwanted microorganisms, comprising at least one of the inventive heteroaryl piperidine and -piperazine derivatives. Said composition is preferably a fungicidal composition which comprises agriculturally suitable auxiliaries, solvents, carriers, surfactants or extenders.

According to the invention, a carrier is a natural or synthetic, organic or inorganic substance with which the active ingredients are mixed or combined for better applicability, in particular for application to plants or plant parts or seed. The carrier, which may be solid or liquid, is generally inert and should be suitable for use in agriculture.

Useful solid carriers include: for example ammonium salts and natural rock flours, such as kaolins, clays, talc, chalk, quartz, attapulgite, montmorillonite or diatomaceous earth, and synthetic rock flours, such as finely divided silica, alumina and silicates; useful solid carriers for granules include: for example, crushed and fractionated natural rocks such as calcite, marble, pumice, sepiolite and dolomite, and also synthetic granules of inorganic and organic flours, and granules of organic material such as paper, sawdust, coconut shells, maize cobs and tobacco stalks; useful emulsifiers and/or foam-formers include: for example nonionic and anionic emulsifiers, such as polyoxyethylene fatty acid esters, polyoxyethylene fatty alcohol ethers, for example alkylaryl polyglycol ethers, alkylsulphonates, alkyl sulphates, arylsulphonates and also protein hydrolysates; suitable dispersants are nonionic and/or ionic substances, for example from the classes of the alcohol-POE and/or -POP ethers, acid and/or POP POE esters, alkylaryl and/or POP POE ethers, fat and/or POP POE adducts, POE- and/or POP-polyol derivatives, POE- and/or POP-sorbitan or -sugar adducts, alkyl or aryl sulphates, alkyl- or arylsulphonates and alkyl or aryl phosphates or the corresponding PO-ether adducts. Further suitable oligomers or polymers are, for example those derived from vinylic monomers, from acrylic acid, from EO and/or PO alone or in combination with, for example, (poly)alcohols or (poly)amines. It is also possible to use lignin and its sulphonic acid derivatives, unmodified and modified celluloses, aromatic and/or aliphatic sulphonic acids and also their adducts with formaldehyde.

The active ingredients can be converted to the customary formulations, such as solutions, emulsions, wettable powders, water- and oil-based suspensions, powders, dusts, pastes, soluble powders, soluble granules, granules for broadcasting, suspoemulsion concentrates, natural products impregnated with active ingredient, synthetic substances impregnated with active ingredient, fertilizers and also microencapsulations in polymeric substances.

The active ingredients can be applied as such, in the form of their formulations or the use forms prepared therefrom, such as ready-to-use solutions, emulsions, water- or oil-based suspensions, powders, wettable powders, pastes, soluble powders, dusts, soluble granules, granules for broadcasting, suspoemulsion concentrates, natural products impregnated with active ingredient, synthetic substances impregnated with

active ingredient, fertilizers and also microencapsulations in polymeric substances. Application is accomplished in a customary manner, for example by watering, spraying, atomizing, broadcasting, dusting, foaming, spreading, etc. It is also possible to apply the active ingredients by the ultralow volume method, or to inject the active ingredient preparation or the active ingredient itself into the soil. It is also possible to treat the seed of the plants.

The formulations mentioned can be prepared in a manner known per se, for example by mixing the active ingredients with at least one customary extender, solvent or diluent, emulsifier, dispersant and/or binder or fixing agent, wetting agent, a water repellent, if appropriate siccatives and UV stabilizers and if appropriate dyes and pigments, antifoams, preservatives, secondary thickeners, tackifiers, gibberellins and also other processing auxiliaries.

The present invention includes not only formulations which are already ready for use and can be deployed with a suitable apparatus to the plant or the seed, but also commercial concentrates which have to be diluted with water prior to use.

The inventive active ingredients may be present as such or in their (commercial) formulations and in the use forms prepared from these formulations as a mixture with other (known) active ingredients, such as insecticides, attractants, sterilants, bactericides, acaricides, nematocides, fungicides, growth regulators, herbicides, fertilizers, safeners and/or semiochemicals.

The auxiliaries used may be those substances which are suitable for imparting particular properties to the composition itself and/or to preparations derived therefrom (for example spray liquors, seed dressings), such as certain technical properties and/or also particular biological properties. Typical auxiliaries include: extenders, solvents and carriers.

Suitable extenders are, for example, water, polar and non-polar organic chemical liquids, for example from the classes of the aromatic and nonaromatic hydrocarbons (such as paraffins, alkylbenzenes, alkyl naphthalenes, chlorobenzenes), the alcohols and polyols (which may optionally also be substituted, etherified and/or esterified), the ketones (such as acetone, cyclohexanone), esters (including fats and oils) and (poly)ethers, the unsubstituted and substituted amines, amides, lactams (such as N-alkylpyrrolidones) and lactones, the sulfones and sulfoxides (such as dimethyl sulfoxide).

Liquefied gaseous extenders or carriers are understood to mean liquids which are gaseous at standard temperature and under standard pressure, for example aerosol propellants such as halohydrocarbons, or else butane, propane, nitrogen and carbon dioxide.

In the formulations it is possible to use tackifiers such as carboxymethylcellulose, natural and synthetic polymers in the form of powders, granules or lattices, such as gum arabic, polyvinyl alcohol and polyvinyl acetate, or else natural phospholipids such as cephalins and lecithins and synthetic phospholipids. Further additives may be mineral and vegetable oils.

If the extender used is water, it is also possible to use, for example, organic solvents as auxiliary solvents. Useful liquid solvents are essentially: aromatics such as xylene, toluene or alkyl naphthalenes, chlorinated aromatics or chlorinated aliphatic hydrocarbons such as chlorobenzenes, chloroethylenes or methylene chloride, aliphatic hydrocarbons such as cyclohexane or paraffins, for example petroleum fractions, alcohols such as butanol or glycol and their ethers and esters, ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone or cyclohexanone, strongly polar solvents such as dimethylformamide and dimethyl sulfoxide, or else water.

The inventive compositions may additionally comprise further components, for example surfactants. Useful surfactants are emulsifiers and/or foam formers, dispersants or wetting agents having ionic or nonionic properties, or mixtures of these surfactants. Examples thereof are salts of polyacrylic acid, salts of lignosulphonic acid, salts of phenolsulphonic acid or naphthalenesulphonic acid, polycondensates of ethylene oxide with fatty alcohols or with fatty acids or with fatty amines, substituted phenols (preferably alkylphenols or arylphenols), salts of sulphosuccinic esters, taurine derivatives (preferably alkyl taurates), phosphoric esters of polyethoxylated alcohols or phenols, fatty esters of polyols, and derivatives of the compounds containing sulphates, sulphonates and phosphates, for example alkylaryl polyglycol ethers, alkylsulphonates, alkyl sulphates, arylsulphonates, protein hydrolysates, lignosulphite waste liquors and methylcellulose. The presence of a surfactant is necessary if one of the active ingredients and/or one of the inert carriers is insoluble in water and when application is effected in water. The proportion of surfactants is between 5 and 40 percent by weight of the inventive composition.

It is possible to use dyes such as inorganic pigments, for example iron oxide, titanium oxide and Prussian Blue, and organic dyes such as alizarin dyes, azo dyes and metal phthalocyanine dyes, and trace nutrients such as salts of iron, manganese, boron, copper, cobalt, molybdenum and zinc.

Further additives may be perfumes, mineral or vegetable, optionally modified oils, waxes and nutrients (including trace nutrients), such as salts of iron, manganese, boron, copper, cobalt, molybdenum and zinc.

Additional components may be stabilizers, such as cold stabilizers, preservatives, antioxidants, light stabilizers, or other agents which improve chemical and/or physical stability.

If appropriate, it is also possible for other additional components to be present, for example protective colloids, binders, adhesives, thickeners, thixotropic substances, penetrants, stabilizers, sequestrants, complexing agents. In general, the active ingredients can be combined with any solid or liquid additive commonly used for formulation purposes.

The formulations contain generally between 0.05 and 99% by weight, 0.01 and 98% by weight, preferably between 0.1 and 95% by weight, more preferably between 0.5 and 90% of active ingredient, most preferably between 10 and 70 percent by weight.

The formulations described above can be used in an inventive method for controlling unwanted microorganisms, in which the inventive heteroaryl piperidine and -piperazine derivatives are applied to the microorganisms and/or in their habitat.

The inventive active ingredients can also be used, as such or in formulations thereof, in a mixture with known fungicides, bactericides, acaricides, nematocides or insecticides, in order thus to broaden, for example, the activity spectrum or to prevent development of resistance.

Useful mixing partners include, for example, known fungicides, insecticides, acaricides, nematocides or else bactericides (see also Pesticide Manual, 14th ed.).

A mixture with other known active ingredients, such as herbicides, or with fertilizers and growth regulators, safeners and/or semiochemicals is also possible.

Application is accomplished in a customary manner appropriate for the use forms.

The invention further comprises a method for treating seed.

A further aspect of the present invention relates in particular to seed treated with at least one of the inventive heteroaryl piperidine and -piperazine derivatives. The inventive

seeds are used in methods for protection of seed from phytopathogenic harmful fungi. In these methods, seed treated with at least one inventive active ingredient is used.

The inventive active ingredients or compositions are also suitable for treating seed. A large part of the damage to crop plants caused by harmful organisms is triggered by the infection of the seed during storage or after sowing, and also during and after germination of the plant. This phase is particularly critical since the roots and shoots of the growing plant are particularly sensitive, and even minor damage may result in the death of the plant. There is therefore a great interest in protecting the seed and the germinating plant by using appropriate compositions.

The control of phytopathogenic harmful fungi by treating the seed of plants has been known for a long time and is the subject of constant improvements. However, the treatment of seed entails a series of problems which cannot always be solved in a satisfactory manner. For instance, it is desirable to develop methods for protecting the seed and the germinating plant, which dispense with, or at least significantly reduce, the additional deployment of crop protection compositions after planting or after emergence of the plants. It is also desirable to optimize the amount of the active ingredient used so as to provide the best possible protection for the seed and the germinating plant from attack by phytopathogenic fungi, but without damaging the plant itself by the active ingredient used. In particular, methods for the treatment of seed should also take account of the intrinsic fungicidal properties of transgenic plants in order to achieve optimal protection of the seed and the germinating plant with a minimum expenditure of crop protection compositions.

The present invention therefore also relates to a method for protecting seed and germinating plants against attack by animal pests and/or phytopathogenic harmful fungi by treating the seed with an inventive composition. The invention likewise relates to the use of the inventive compositions for treatment of seed to protect the seed and the germinating plant from phytopathogenic fungi. The invention further relates to seed which has been treated with an inventive composition for protection from phytopathogenic fungi.

Animal pests and/or phytopathogenic harmful fungi which damage plants post-emergence are controlled primarily by the treatment of the soil and of the exposed parts of plants with crop protection compositions. Owing to the concerns regarding a possible influence of the crop protection compositions on the environment and the health of humans and animals, there are efforts to reduce the amount of active ingredients deployed.

One of the advantages of the present invention is that, because of the particular systemic properties of the inventive compositions, the treatment of the seed with these compositions not only protects the seed itself, but also the resulting plants after emergence, from animal pests and/or phytopathogenic harmful fungi. In this way, the immediate treatment of the crop at the time of sowing or shortly thereafter can be dispensed with.

It is likewise considered to be advantageous that the inventive active ingredients or compositions can especially also be used with transgenic seed, in which case the plant growing from this seed is capable of expressing a protein which acts against pests. By virtue of the treatment of such seed with the inventive active ingredients or compositions, merely the expression of the protein, for example an insecticidal protein, can control certain pests. Surprisingly, a further synergistic effect can be observed in this case, which additionally increases the effectiveness for protection against attack by pests.

The inventive compositions are suitable for protection of seed of any plant variety which is used in agriculture, in the greenhouse, in forests or in horticulture. More particularly, the seed is that of cereals (such as wheat, barley, rye, millet and oats), maize, cotton, soya, rice, potatoes, sunflower, bean, coffee, beet (e.g. sugar beet and fodder beet), peanut, vegetables (such as tomato, cucumber, onions and lettuce), lawns and ornamental plants. Of particular significance is the treatment of the seed of cereals (such as wheat, barley, rye and oats), maize and rice.

As also described below, the treatment of transgenic seed with the inventive active ingredients or compositions is of particular significance. This relates to the seed of plants containing at least one heterologous gene which enables the expression of a polypeptide or protein having insecticidal properties. The heterologous gene in transgenic seed may originate, for example, from microorganisms of the species *Bacillus*, *Rhizobium*, *Pseudomonas*, *Serratia*, *Trichoderma*, *Clavibacter*, *Glomus* or *Gliocladium*. This heterologous gene preferably originates from *Bacillus* sp., in which case the gene product is effective against the European corn borer and/or the Western corn rootworm. The heterologous gene more preferably originates from *Bacillus thuringiensis*.

In the context of the present invention, the inventive composition is applied to the seed alone or in a suitable formulation. Preferably, the seed is treated in a state in which it is sufficiently stable for no damage to occur in the course of treatment. In general, the seed can be treated at any time between harvest and sowing. It is customary to use seed which has been separated from the plant and freed from cobs, shells, stalks, coats, hairs or the flesh of the fruits. For example, it is possible to use seed which has been harvested, cleaned and dried down to a moisture content of less than 15% by weight. Alternatively, it is also possible to use seed which, after drying, for example, has been treated with water and then dried again.

When treating the seed, care must generally be taken that the amount of the inventive composition applied to the seed and/or the amount of further additives is selected such that the germination of the seed is not impaired, or that the resulting plant is not damaged. This has to be borne in mind particularly in the case of active ingredients which can have phytotoxic effects at certain application rates.

The inventive compositions can be applied directly, i.e. without containing any other components and without having been diluted. In general, it is preferable to apply the compositions to the seed in the form of a suitable formulation. Suitable formulations and methods for seed treatment are known to those skilled in the art and are described, for example, in the following documents: U.S. Pat. Nos. 4,272, 417, 4,245,432, 4,808,430, 5,876,739, US 2003/0176428, WO 2002/080675, WO 2002/028186.

The active ingredients usable in accordance with the invention can be converted to the customary seed dressing formulations, such as solutions, emulsions, suspensions, powders, foams, slurries or other coating compositions for seed, and also ULV formulations.

These formulations are prepared in a known manner, by mixing the active ingredients or active ingredient combinations with customary additives, for example customary extenders and solvents or diluents, dyes, wetting agents, dispersants, emulsifiers, antifoams, preservatives, secondary thickeners, tackifiers, gibberellins, and also water.

Useful dyes which may be present in the seed dressing formulations usable in accordance with the invention are all dyes which are customary for such purposes. It is possible to use either pigments, which are sparingly soluble in water, or

dyes, which are soluble in water. Examples include the dyes known by the names Rhodamine B, C.I. Pigment Red 112 and C.I. Solvent Red 1.

Useful wetting agents which may be present in the seed dressing formulations usable in accordance with the invention are all substances which promote wetting and which are conventionally used for the formulation of active agrochemical ingredients. Preference is given to using alkyl naphthalenesulphonates, such as diisopropyl or diisobutyl naphthalenesulphonates.

Useful dispersants and/or emulsifiers which may be present in the seed dressing formulations usable in accordance with the invention are all nonionic, anionic and cationic dispersants conventionally used for the formulation of active agrochemical ingredients. Usable with preference are non-ionic or anionic dispersants or mixtures of nonionic or anionic dispersants. Suitable nonionic dispersants include especially ethylene oxide/propylene oxide block polymers, alkylphenol polyglycol ethers and tristyrylphenol polyglycol ether, and the phosphated or sulphated derivatives thereof. Suitable anionic dispersants are especially lignosulfonates, polyacrylic acid salts and arylsulfonate/formaldehyde condensates.

Antifoams which may be present in the seed dressing formulations usable in accordance with the invention are all foam-inhibiting substances conventionally used for the formulation of active agrochemical ingredients. Silicone antifoams and magnesium stearate can be used with preference.

Preservatives which may be present in the seed dressing formulations usable in accordance with the invention are all substances usable for such purposes in agrochemical compositions. Examples include dichlorophene and benzyl alcohol hemiformal.

Secondary thickeners which may be present in the seed dressing formulations usable in accordance with the invention are all substances usable for such purposes in agrochemical compositions. Preferred examples include cellulose derivatives, acrylic acid derivatives, xanthan, modified clays and finely divided silica.

Adhesives which may be present in the seed dressing formulations usable in accordance with the invention are all customary binders usable in seed dressing products. Preferred examples include polyvinylpyrrolidone, polyvinyl acetate, polyvinyl alcohol and tylose.

The gibberellins which may be present in the seed dressing formulations usable in accordance with the invention may preferably be gibberellins A1, A3 (=gibberellic acid), A4 and A7; particular preference is given to using gibberellic acid. The gibberellins are known (cf. R. Wegler "Chemie der Pflanzenschutz- und Schädlingsbekämpfungsmittel" [Chemistry of the Crop Protection Compositions and Pesticides], vol. 2, Springer Verlag, 1970, p. 401-412).

The seed dressing formulations usable in accordance with the invention can be used to treat a wide variety of different kinds of seed either directly or after prior dilution with water. For instance, the concentrates or the preparations obtainable therefrom by dilution with water can be used to dress the seed of cereals, such as wheat, barley, rye, oats, and triticale, and also the seed of maize, rice, oilseed rape, peas, beans, cotton, sunflowers, and beets, or else a wide variety of different vegetable seed. The seed dressing formulations usable in accordance with the invention, or the dilute preparations thereof, can also be used to dress seed of transgenic plants. In this case, additional synergistic effects may also occur in interaction with the substances formed by expression.

For treatment of seed with the seed dressing formulations usable in accordance with the invention, or the preparations

prepared therefrom by adding water, all mixing units usable customarily for the seed dressing are useful. Specifically, the procedure in the seed dressing is to place the seed into a mixer, to add the particular desired amount of seed dressing formulations, either as such or after prior dilution with water, and to mix everything until the formulation is distributed homogeneously on the seed. If appropriate, this is followed by a drying operation.

The application rate of the seed dressing formulations usable in accordance with the invention can be varied within a relatively wide range. It is guided by the particular content of the active ingredients in the formulations and by the seed. The application rates of active ingredient combination are generally between 0.001 and 50 g per kilogram of seed, preferably between 0.01 and 15 g per kilogram of seed.

In addition, the inventive compounds of the formula (I) also have very good antimycotic effects. They have a very broad antimycotic activity spectrum, especially against dermatophytes and yeasts, moulds and diphasic fungi (for example against *Candida* species, such as *Candida albicans*, *Candida glabrata*), and *Epidermophyton floccosum*, *Aspergillus* species, such as *Aspergillus niger* and *Aspergillus fumigatus*, *Trichophyton* species, such as *Trichophyton mentagrophytes*, *Microsporon* species such as *Microsporon canis* and *audouinii*. The enumeration of these fungi by no means constitutes a restriction of the mycotic spectrum covered, and is merely of illustrative character.

The inventive active ingredients of the formula (I) can therefore be used both in medical and in non-medical applications.

The active ingredients can be used as such, in the form of their formulations or the use forms prepared therefrom, such as ready-to-use solutions, suspensions, wettable powders, pastes, soluble powders, dusts and granules. Application is accomplished in a customary manner, for example by watering, spraying, atomizing, broadcasting, dusting, foaming, spreading, etc. It is also possible to apply the active ingredients by the ultra-low volume method, or to inject the active ingredient preparation or the active ingredient itself into the soil. It is also possible to treat the seed of the plants.

When using the inventive active ingredients as fungicides, the application rates can be varied within a relatively wide range, depending on the kind of application. The application rate of the inventive active ingredients is

in the case of treatment of plant parts, for example leaves: from 0.1 to 10 000 g/ha, preferably from 10 to 1000 g/ha, more preferably from 50 to 300 g/ha (in the case of application by watering or dripping, it is even possible to reduce the application rate, especially when inert substrates such as rockwool or perlite are used);
in the case of seed treatment: from 2 to 200 g per 100 kg of seed, preferably from 3 to 150 g per 100 kg of seed, more preferably from 2.5 to 25 g per 100 kg of seed, even more preferably from 2.5 to 12.5 g per 100 kg of seed;
in the case of soil treatment: from 0.1 to 10 000 g/ha, preferably from 1 to 5000 g/ha.

These application rates are merely by way of example and are not limiting for the purposes of the invention.

The inventive active ingredients are used in the veterinary sector and in animal husbandry in a known manner by enteral administration in the form of, for example, tablets, capsules, potions, drenches, granules, pastes, boluses, the feed-through process, in the form of suppositories, by parenteral administration, such as, for example, by injection (intramuscular, subcutaneous, intravenous, intraperitoneal and the like), implants, by nasal administration, by dermal use in the form, for example, of dipping or bathing, spraying, pouring on and

spotting on, washing and powdering, and also with the aid of moulded articles containing the active ingredient, such as collars, ear marks, tail marks, limb bands, halters, marking devices and the like.

When used for livestock, poultry, domestic animals and the like, the active ingredients of the formula (I) can be used as formulations (for example powders, emulsions, flowables) comprising the active ingredients in an amount of 1 to 80% by weight, either directly or after 100 to 10 000-fold dilution, or they may be used as a chemical bath.

The ready-to-use compositions may optionally also comprise other insecticides, and optionally also one or more fungicides.

With respect to possible additional mixing partners, reference is made to the insecticides and fungicides mentioned above.

At the same time, the inventive compounds can be used for protection of objects which come into contact with saltwater or brackish water, especially hulls, screens, nets, buildings, moorings and signalling systems, against fouling.

In addition, the inventive compounds can be used as antifouling compositions, alone or in combinations with other active ingredients.

The inventive treatment method can be used for the treatment of genetically modified organisms (GMOs), for example plants or seeds. Genetically modified plants (or transgenic plants) are plants in which a heterologous gene has been integrated stably into the genome. The expression "heterologous gene" essentially means a gene which is provided or assembled outside the plant and, when introduced into the nuclear, chloroplastic or hypochondrial genome gives the transformed plant new or improved agronomic or other properties by expressing a protein or polypeptide of interest or by downregulating or silencing other gene(s) which are present in the plant (using for example antisense technology, cosuppression technology or RNAi technology [RNA interference]). A heterologous gene present in the genome is also called a transgene. A transgene that is defined by its specific presence in the plant genome is called a transformation or transgenic event.

Depending on the plant species or plant cultivars, their location and growth conditions (soils, climate, vegetation period, diet), the treatment according to the invention may also result in superadditive ("synergistic") effects. For example, the following effects exceeding the effects actually to be expected are possible: reduced application rates and/or a widening of the activity spectrum and/or an increase in the activity of the active ingredients and compositions which can be used according to the invention, better plant growth, increased tolerance to high or low temperatures, increased tolerance to drought or to water or soil salt content, increased flowering performance, easier harvesting, accelerated maturation, higher harvest yields, bigger fruits, larger plant height, greener leaf colour, earlier flowering, higher quality and/or a higher nutritional value of the harvested products, higher sugar concentration within the fruits, better storage stability and/or processability of the harvested products.

At certain application rates, the inventive active ingredient combinations may also have a fortifying effect on plants. They are therefore suitable for mobilizing the defence system of the plant against attack by unwanted phytopathogenic fungi and/or microorganisms and/or viruses. This may be one of the reasons for the enhanced activity of the inventive combinations, for example against fungi. Plant-fortifying (resistance-inducing) substances shall be understood to mean, in the present context, also those substances or combinations of substances which are capable of stimulating the defence sys-

tem of plants in such a way that, when subsequently inoculated with unwanted phytopathogenic fungi and/or microorganisms and/or viruses, the plants treated display a substantial degree of resistance to these unwanted phytopathogenic fungi and/or microorganisms and/or viruses. In the present case, unwanted phytopathogenic fungi and/or microorganisms and/or viruses are understood to mean phytopathogenic fungi, bacteria and viruses. The inventive substances can therefore be used for protection of plants from attack by the pathogens mentioned within a certain period of time after the treatment. The period within which protection is achieved generally extends for from 1 to 10 days, preferably 1 to 7 days, after the treatment of the plants with the active ingredients.

Plants and plant cultivars which are preferably treated in accordance with the invention include all plants which have genetic material which imparts particularly advantageous, useful traits to these plants (whether obtained by breeding and/or biotechnological means).

Plants and plant cultivars which are also preferably treated in accordance with the invention are resistant against one or more biotic stress factors, i.e. said plants have a better defence against animal and microbial pests, such as against nematodes, insects, mites, phytopathogenic fungi, bacteria, viruses and/or viroids.

Plants and plant cultivars which can likewise be treated in accordance with the invention are those plants which are resistant to one or more abiotic stress factors. The abiotic stress conditions may include, for example, drought, cold and hot conditions, osmotic stress, waterlogging, elevated soil salinity, elevated exposure to minerals, ozone conditions, strong light conditions, limited availability of nitrogen nutrients, limited availability of phosphorus nutrients or avoidance of shade.

Plants and plant cultivars which can likewise be treated in accordance with the invention are those plants which are characterized by enhanced yield characteristics. Enhanced yield in these plants may be the result of, for example, improved plant physiology, improved plant growth and development, such as water use efficiency, water retention efficiency, improved nitrogen use, enhanced carbon assimilation, improved photosynthesis, increased germination efficiency and accelerated maturation. Yield can also be affected by improved plant architecture (under stress and non-stress conditions), including early flowering, flowering control for hybrid seed production, seedling vigor, plant size, internode number and distance, root growth, seed size, fruit size, pod size, pod or ear number, seed number per pod or ear, seed mass, enhanced seed filling, reduced seed dispersal, reduced pod dehiscence and lodging resistance. Further yield traits include seed composition, such as carbohydrate content, protein content, oil content and composition, nutritional value, reduction in anti-nutritional compounds, improved processability and better storage stability.

Plants that may be treated according to the invention are hybrid plants that already express the characteristics of heterosis, or hybrid effect, which results in generally higher yield, vigour, health and resistance towards biotic and abiotic stress factors. Such plants are typically produced by crossing an inbred male-sterile parent line (the female parent) with another inbred male-fertile parent line (the male parent). The hybrid seed is typically harvested from the male-sterile plants and sold to growers. Male-sterile plants can sometimes (e.g. in corn) be produced by detasseling (i.e. the mechanical removal of the male reproductive organs or male flowers) but, more typically, male sterility is the result of genetic determinants in the plant genome. In that case, and especially when

seed is the desired product to be harvested from the hybrid plants, it is typically beneficial to ensure that male fertility in hybrid plants, which contain the genetic determinants responsible for male sterility, is fully restored. This can be accomplished by ensuring that the male parents have appropriate fertility restorer genes which are capable of restoring the male fertility in hybrid plants that contain the genetic determinants responsible for male sterility. Genetic determinants for male sterility may be located in the cytoplasm. Examples of cytoplasmic male sterility (CMS) were for instance described for *Brassica* species. However, genetic determinants for male sterility can also be located in the nuclear genome. Male-sterile plants can also be obtained by plant biotechnology methods such as genetic engineering. A particularly useful means of obtaining male-sterile plants is described in WO 89/10396, in which, for example, a ribonuclease such as a barnase is selectively expressed in the tapetum cells in the stamens. Fertility can then be restored by expression in the tapetum cells of a ribonuclease inhibitor such as barstar.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may be treated according to the invention are herbicide-tolerant plants, i.e. plants made tolerant to one or more given herbicides. Such plants can be obtained either by genetic transformation, or by selection of plants containing a mutation imparting such herbicide tolerance.

Herbicide-tolerant plants are, for example, glyphosate-tolerant plants, i.e. plants which have been made tolerant to the herbicide glyphosate or salts thereof. For example, glyphosate-tolerant plants can be obtained by transforming the plant with a gene which encodes the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). Examples of such EPSPS genes are the AroA gene (mutant CT7) of the bacterium *Salmonella typhimurium*, the CP4 gene of the bacterium *Agrobacterium* sp., the genes encoding a petunia EPSPS, a tomato EPSPS, or an *Eleusine* EPSPS. It can also be a mutated EPSPS. Glyphosate-tolerant plants can also be obtained by expressing a gene that encodes a glyphosate oxidoreductase enzyme. Glyphosate-tolerant plants can also be obtained by expressing a gene that encodes a glyphosate acetyl transferase enzyme. Glyphosate-tolerant plants can also be obtained by selecting plants naturally-occurring mutations of the above-mentioned genes.

Other herbicide-resistant plants are for example plants that have been made tolerant to herbicides inhibiting the enzyme glutamine synthase, such as bialaphos, phosphinothricin or glufosinate. Such plants can be obtained by expressing an enzyme detoxifying the herbicide or a mutant glutamine synthase enzyme that is resistant to inhibition. One such efficient detoxifying enzyme is, for example, an enzyme encoding a phosphinothricin acetyltransferase (for example the bar or pat protein from *Streptomyces* species). Plants expressing an exogenous phosphinothricin acetyltransferase have been described.

Further herbicide-tolerant plants are also plants that have been made tolerant to the herbicides inhibiting the enzyme hydroxyphenylpyruvate dioxygenase (HPPD). Hydroxyphenylpyruvate dioxygenases are enzymes that catalyze the reaction in which para-hydroxyphenylpyruvate (HPP) is converted to homogentisate. Plants tolerant to HPPD inhibitors can be transformed with a gene encoding a naturally occurring resistant HPPD enzyme, or a gene encoding a mutated HPPD enzyme. Tolerance to HPPD inhibitors can also be obtained by transforming plants with genes encoding certain enzymes enabling the formation of homogentisate despite the inhibition of the native HPPD enzyme by the HPPD inhibitor. Tolerance of plants to HPPD inhibitors can also be improved

by transforming plants with a gene encoding an enzyme prephenate dehydrogenase in addition to a gene encoding an HPPD-tolerant enzyme.

Further herbicide-resistant plants are plants that have been made tolerant to acetolactate synthase (ALS) inhibitors. The known ALS inhibitors include, for example, sulfonylurea, imidazolinone, triazolopyrimidines, pyrimidinyl oxy(thio) benzoates and/or sulfonylaminocarbonyltriazolinone herbicides. Different mutations in the ALS enzyme (also known as acetohydroxy acid synthase, AHAS) are known to confer tolerance to different herbicides and groups of herbicides. The production of sulphonylurea-tolerant plants and imidazolinone-tolerant plants has been described in the international publication WO 1996/033270. Further sulphonylurea- and imidazolinone-tolerant plants have also been described, for example in WO 2007/024782.

Other plants tolerant to imidazolinone and/or sulphonylurea can be obtained by induced mutagenesis, by selection in cell cultures in the presence of the herbicide or by mutation breeding.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are insect-resistant transgenic plants, i.e. plants made resistant to attack by certain target insects. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation which imparts such insect resistance.

In the present context, the term "insect-resistant transgenic plant" includes any plant containing at least one transgene comprising a coding sequence which encodes the following:

- 1) an insecticidal crystal protein from *Bacillus thuringiensis* or an insecticidal portion thereof, such as the insecticidal crystal proteins compiled online at: http://www.lifesci.sussex.ac.uk/Home/Neil_Crickmore/Bt/, or insecticidal portions thereof, for example proteins of the Cry protein classes Cry1Ab, Cry1Ac, Cry1F, Cry2Ab, Cry3Ae or Cry3Bb or insecticidal portions thereof; or
- 2) a crystal protein from *Bacillus thuringiensis* or a portion thereof which is insecticidal in the presence of a second other crystal protein as *Bacillus thuringiensis* or a portion thereof, such as the binary toxin made up of the Cy34 and Cy35 crystal proteins; or
- 3) a hybrid insecticidal protein comprising parts of two different insecticidal crystal proteins from *Bacillus thuringiensis*, such as a hybrid of the proteins of 1) above or a hybrid of the proteins of 2) above, for example the Cry1A.105 protein produced by maize event MON98034 (WO 2007/027777); or
- 4) a protein of any one of points 1) to 3) above wherein some, particularly 1 to 10, amino acids have been replaced by another amino acid to obtain a higher insecticidal activity to a target insect species, and/or to expand the range of target insect species affected, and/or because of changes induced in the encoding DNA during cloning or transformation, such as the Cry3Bb1 protein in maize events MON863 or MON88017, or the Cry3A protein in maize event MIR604; or
- 5) an insecticidal secreted protein from *Bacillus thuringiensis* or *Bacillus cereus*, or an insecticidal portion thereof, such as the vegetative insecticidal proteins (VIP) listed at: http://www.lifesci.sussex.ac.uk/home/Neil_Crickmore/Bt/vip.html, for example proteins from the VIP3Aa protein class; or
- 6) a secreted protein from *Bacillus thuringiensis* or *Bacillus cereus* which is insecticidal in the presence of a second

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secreted protein from *Bacillus thuringiensis* or *B. cereus*, such as the binary toxin made up of the VIP 1A and VIP2A proteins;

- 7) a hybrid insecticidal protein comprising parts from different secreted proteins from *Bacillus thuringiensis* or *Bacillus cereus*, such as a hybrid of the proteins in 1) above or a hybrid of the proteins in 2) above; or
- 8) a protein of any one of points 1) to 3) above wherein some, particularly 1 to 10, amino acids have been replaced by another amino acid to obtain a higher insecticidal activity to a target insect species, and/or to expand the range of target insect species affected, and/or because of changes induced in the encoding DNA during cloning or transformation (while still encoding an insecticidal protein), such as the VIP3Aa protein in cotton event COT102.

Of course, insect-resistant transgenic plants, as used herein, also include any plant comprising a combination of genes encoding the proteins of any one of the abovementioned classes 1 to 8. In one embodiment, an insect-resistant plant contains more than one transgene encoding a protein of any one of the abovementioned classes 1 to 8, to expand the range of target insect species affected or to delay insect resistance development to the plants, by using different proteins insecticidal to the same target insect species but having a different mode of action, such as binding to different receptor binding sites in the insect.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are tolerant to abiotic stress factors. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation imparting such stress resistance. Particularly useful stress-tolerant plants include the following:

- a. plants which contain a transgene capable of reducing the expression and/or the activity of the poly(ADP-ribose) polymerase (PARP) gene in the plant cells or plants;
- b. plants which contain a stress tolerance-enhancing transgene capable of reducing the expression and/or the activity of the PARP-encoding genes of the plants or plant cells;
- c. plants which contain a stress tolerance-enhancing transgene coding for a plant-functional enzyme of the nicotinamide adenine dinucleotide salvage biosynthesis pathway, including nicotinamidase, nicotinate phosphoribosyltransferase, nicotinic acid mononucleotide adenyltransferase, nicotinamide adenine dinucleotide synthetase or nicotinamide phosphoribosyltransferase.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention show altered quantity, quality and/or storage stability of the harvested product and/or altered properties of specific ingredients of the harvested product such as:

- 1) Transgenic plants which synthesize a modified starch which is altered with respect to its chemophysical traits, in particular the amylose content or the amylose/amylopectin ratio, the degree of branching, the average chain length, the distribution of the side chains, the viscosity behaviour, the gel resistance, the grain size and/or grain morphology of the starch in comparison to the synthesized starch in wild-type plant cells or plants, such that this modified starch is better suited for certain applications.
- 2) Transgenic plants which synthesize non-starch carbohydrate polymers or which synthesize non-starch carbohydrate polymers with altered properties in comparison to wild-type plants without genetic modification. Examples are plants which produce polyfructose, especially of the inulin and levan type, plants which produce alpha-1,4-

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glucans, plants which produce alpha-1,6-branched alpha-1,4-glucans, and plants producing alternan.

- 3) Transgenic plants which produce hyaluronan.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are plants, such as cotton plants, with altered fibre characteristics. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation imparting such altered fibre characteristics and include:

- a) plants, such as cotton plants, which contain an altered form of cellulose synthase genes;
- b) plants, such as cotton plants, which contain an altered form of rsw2 or rsw3 homologous nucleic acids;
- c) plants, such as cotton plants, with an increased expression of sucrose phosphate synthase;
- d) plants, such as cotton plants, with an increased expression of sucrose synthase;
- e) plants, such as cotton plants, wherein the timing of the plasmodesmatal gating at the basis of the fibre cell is altered, for example through downregulation of fibre-selective β -1,3-glucanase;
- f) plants, such as cotton plants, which have fibres with altered reactivity, for example through the expression of the N-acetylglucosaminetransferase gene including nodC and chitin synthase genes.

Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are plants, such as oilseed rape or related *Brassica* plants, with altered oil profile characteristics. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation imparting such altered oil characteristics and include:

- a) plants, such as oilseed rape plants, which produce oil having a high oleic acid content;
- b) plants, such as oilseed rape plants, which produce oil having a low linolenic acid content;
- c) plants, such as oilseed rape plants, which produce oil having a low level of saturated fatty acids.

Particularly useful transgenic plants which may be treated according to the invention are plants which comprise one or more genes which encode one or more toxins are the transgenic plants which are sold under the following trade names: YIELD GARD® (for example corn, cotton, soybeans), KnockOut® (for example corn), BiteGard® (for example corn), BT-Xtra® (for example corn), StarLink® (for example corn), Bollgard® (cotton), Nucotn® (cotton), Nucotn 33B® (cotton), NatureGard® (for example corn), Protecta® and NewLeaf® (potato). Examples of herbicide-tolerant plants which should be mentioned are corn varieties, cotton varieties and soybean varieties which are available under the following trade names: Roundup Ready® (tolerance to glyphosate, for example corn, cotton, soybeans), Liberty Link® (tolerance to phosphinothricin, for example oilseed rape), IMI® (tolerance to imidazolinone) and SCS® (tolerance to sulfonylurea, for example corn). Herbicide-resistant plants (plants bred in a conventional manner for herbicide tolerance) which should be mentioned include the varieties sold under the Clearfield® name (for example corn).

Particularly useful transgenic plants which may be treated according to the invention are plants containing transformation events, or a combination of transformation events, and that are listed for example in the databases for various national or regional regulatory agencies (see for example http://gmoinfo.jrc.it/gmp_browser.aspx and <http://www.ag-bios.com/dbase.php>).

The plants listed can be treated in accordance with the invention in a particularly advantageous manner with the compounds of the general formula (I) and/or the active ingredient mixtures according to the invention. The preferred ranges stated above for the active ingredients or mixtures also apply to the treatment of these plants. Particular emphasis is given to the treatment of plants with the compounds or mixtures specifically mentioned in the present text.

The inventive active ingredients or compositions can thus be used to protect plants from attack by the pathogens mentioned for a certain period of time after treatment. The period for which protection is provided extends generally for 1 to 28 days, preferably for 1 to 14 days, more preferably for 1 to 10 days, even more preferably for 1 to 7 days, after the treatment of the plants with the active ingredients, or for up to 200 days after a seed treatment.

The preparation and the use of the inventive active ingredients of the formula (I) is illustrated by the examples which follow. However, the invention is not limited to these examples.

General notes: Unless stated otherwise, all chromatographic purification and separation steps are carried out on silica gel and using a solvent gradient from 0:100 ethyl acetate/cyclohexane to 100:0 ethyl acetate/cyclohexane.

Preparation of Starting Materials

tert-Butyl 4-{4-[(hydroxyimino)methyl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (A)

To a solution of tert-butyl 4-(4-formyl-1,3-thiazol-2-yl)piperidine-1-carboxylate (10.0 g) in ethanol (110 ml) is added dropwise hydroxylamine (50% in water, 2.48 ml). The mixture is heated to reflux for 2 hours. Volatile substances are subsequently removed under reduced pressure. This gives tert-butyl 4-{4-[(hydroxyimino)methyl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (10.5 g, 100%).

log P (pH 2.7): 2.25, 2.38

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm}: 1.41 (s, 9H), 1.49-1.60 (m, 2H), 1.99-2.06 (m, 2H), 2.82-2.96 (m, 2H), 3.16-3.24 (m, 1H), 3.96-4.05 (m, 2H), 7.62 (s, 0.15H), 7.76 (s, 0.85H), 8.13 (s, 0.85H), 8.39 (s, 0.15H), 11.22 (s, 0.85H), 11.95 (s, 0.15H)

MS (ESI): 312 ([M+H]⁺)

tert-Butyl 4-{4-[5-(ethoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (B)

To a solution of tert-butyl 4-{4-[(hydroxyimino)methyl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (A, 2.00 g) in dimethylformamide (40 ml) is added, at room temperature, N-chlorosuccinimide (0.90 g). The reaction mixture is stirred at 40° C. for 3 h. Subsequently, at room temperature, a solution of ethyl acrylate (0.77 g) in tetrahydrofuran (20 ml) and triethylamine (0.98 g) are successively added dropwise to the mixture. The reaction mixture is stirred at room temperature overnight, and then water is added. The aqueous phase is removed and extracted with ethyl acetate. Then the combined organic phases are dried over sodium sulfate. The solids are filtered off and the solvent is distilled off. The residue is purified by chromatography. This gives tert-butyl 4-{4-[5-(ethoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (2.30 g, 79%).

log P (pH 2.7): 3.14

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm}: 1.22 (t, 3H), 1.41 (s, 9H), 1.46-1.63 (m, 2H), 1.97-2.09 (m, 2H), 2.80-2.97 (m,

2H), 3.52-3.61 (m, 1H), 3.68-3.80 (m, 1H), 3.96-4.05 (m, 2H), 4.16 (q, 2H), 5.20-5.27 (m, 1H), 8.05 (s, 1H)

MS (ESI): 310 ([M+H-C(CH₃)₃]⁺)

4-{4-[5-(Methoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidinium chloride (C)

Under an argon atmosphere, at 0° C., a 4 N solution of hydrogen chloride in dioxane (11.4 ml) is added dropwise to a solution of tert-butyl 4-{4-[5-(methoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidine-1-carboxylate (B), 1.20 g) in dioxane (12 ml). The reaction mixture is stirred at 0° C. and then gradually warmed to room temperature. After 4 hours, the solvent and excess hydrogen chloride are removed. This gives 4-{4-[5-(methoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidinium chloride (1.10 g, 98%).

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm}: 1.85-2.02 (m, 2H), 2.11-2.22 (m, 2H), 2.92-3.10 (m, 2H), 3.30-3.38 (m, 2H), 3.71 (s, 3H), 5.23-5.31 (m, 1H), 8.09 (s, 1H), 8.90 (bs, 1H), 9.20 (bs, 1H)

Methyl 3-[2-(1-{[3,5-bis(difluoromethyl)-1,1-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylate (I-1)

To a solution of [3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetic acid (0.83 g) in dichloromethane (10 ml) are added, at 0° C., oxalyl chloride (1.26 g) and one drop of N,N-dimethylformamide. The mixture is stirred at room temperature for 60 minutes. The solvent and the excess reagent are removed under reduced pressure. The solid residue is dissolved again in dichloromethane and added dropwise at 0° C. to a solution of 4-{4-[5-(methoxycarbonyl)-4,5-dihydro-1,2-oxazol-3-yl]-1,3-thiazol-2-yl}piperidinium chloride (C) and triethylamine (4.6 ml) in dichloromethane (14 ml). The reaction mixture is stirred at room temperature for 3 h. Then concentrated sodium hydrogencarbonate solution is added thereto, and the aqueous phase is removed and extracted with ethyl acetate. The combined organic phases are dried over sodium sulphate and concentrated. Purification by column chromatography gives methyl 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylate (1.1 g, 57%).

log P (pH 2.7): 2.26

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm}: 1.51-1.60 (m, 1H), 1.74-1.85 (m, 1H), 2.05-2.14 (m, 2H), 2.80-2.88 (m, 2H), 3.21-3.30 (m, 1H), 3.58-3.65 (m, 1H), 3.71 (s, 3H), 3.70-3.79 (m, 1H), 3.92-3.98 (m, 1H), 4.30-4.37 (m, 1H), 5.26-5.30 (m, 1H), 5.35-5.46 (m, 2H), 6.91 (s, 1H), 7.04 (t, 1H), 7.18 (t, 1H), 8.08 (s, 1H)

MS (ESI): 504 ([M+H]⁺)

3-[2-(1-{[3,5-Bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylic acid (D)

To a solution of methyl 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylate (I-1) (1.1 g) in tetrahydrofuran (7 ml) and water (2 ml) is added, at room temperature, lithium hydroxide monohydrate (0.28 g). The mixture is stirred at room temperature for 20 minutes, and then ice-cold 1N HCl solution is added. The aqueous phase is extracted with ethyl acetate and the combined organic phases are dried over sodium sulphate. The solids are filtered off and the solvent is distilled off. This gives 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylic acid (D)

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luoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylic acid (0.82 g, 73%).

log P (pH 2.7): 1.77

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm} : 1.50-1.63 (m, 1H), 1.74-1.88 (m, 1H), 2.05-2.17 (m, 2H), 2.79-2.89 (m, 1H), 3.52-3.60 (m, 1H), 3.66-3.75 (m, 1H), 3.92-4.00 (m, 1H), 4.31-4.38 (m, 1H), 5.12-5.16 (m, 1H), 5.32-5.45 (m, 2H), 6.90 (s, 1H), 7.02 (t, 1H), 7.16 (t, 1H), 8.06 (s, 1H)

MS (ESI): 490 ([M+H]⁺)

Preparation of Compounds of the Formula (I)

2-Chlorocyclohexyl 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylate (I-5)

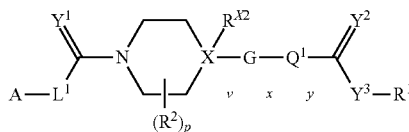
To a solution of 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylic acid (E, 160 mg) in dichloromethane (5 ml) are added, at room temperature, 2-chlorocyclohexanol (57 mg), 4-dimethylaminopyridine (4 mg) and 1-ethyl-3-(3'-dimethylaminopropyl)carbodiimide hydrochloride (94 mg). The mixture is stirred overnight, and water is then added. The aqueous phase is removed and extracted with ethyl acetate. The combined organic phases are

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Analogously to the above examples and in accordance with the general descriptions of the processes according to the invention, it is possible to obtain the compounds of the formula (I) listed in Table 1 below.

(I)

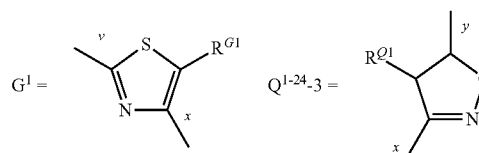
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The structural elements G and Q¹ listed in Table 1 are defined as follows:

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For all compounds listed in Table 1, p=0.
If Y³=O, R¹³ must be empty.

TABLE 1

Ex.	A	L1	Y ¹	XR ^{x2}	G	R ^{G1}	Q ¹	R ^{Q1}	Y ²	Y ³	R ¹³	R ¹	log p
I-1	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		CH ₃	2.28 ^[a] ; 2.28 ^[b]
I-2	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		2-fluorocyclohexyl	3.17 ^[a] ; 3.19 ^[b]
I-3	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		(1R,2S)-2-phenylcyclohexyl	4.1 ^[b] ; 4.02 ^[a]
I-4	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		(1S,2R)-2-cyanocyclohexyl	2.95 ^[b] ; 2.91 ^[a]
I-5	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		2-chlorocyclohexyl	3.42 ^[a] ; 3.5 ^[b]
I-6	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		1,2,3,4-tetrahydronaphthalen-1-yl	3.73 ^[a] ; 3.79 ^[b]
I-7	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	O		2,6-difluorobenzyl	3.23 ^[b] ; 3.22 ^[a]
I-8	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	NR ¹³	H	2-chlorobenzyl	2.88 ^[a] ; 2.89 ^[b]
I-9	3,5-bis(difluoromethyl)-1H-pyrazol-1-yl	CH ₂	O	CH	G ¹	H	Q ^{1-24,3}	H	O	NR ¹³	H	2,4-dichlorobenzyl	3.33 ^[b] ; 3.29 ^[a]

Astatine-centred stereochemical specification of chiral radicals: chiral radicals are specified as if they were bonded to astatine

The logP values were determined in accordance with EEC Directive 79/831 Annex V.A8 by HPLC (High Performance Liquid Chromatography) using reversed-phase columns (C 18) by the following methods:

^[a]The determination is made in the acid range at pH 2.3 with 0.1% aqueous phosphoric acid and acetonitrile as eluents; linear gradient from 10% acetonitrile to 95% acetonitrile.

^[b]The LC-MS determination in the neutral range is effected at pH 7.8 using 0.001 molar aqueous ammonium hydrogencarbonate solution and acetonitrile as eluents; linear gradient from 10% acetonitrile to 95% acetonitrile

The calibration is effected with unbranched alkan-2-ones (having 3 to 16 carbon atoms) with known logP values (logP values determined on the basis of the retention times by linear interpolation between two successive alkanones).

) The lambda max values were determined in the maxima of the chromatographic signals using the UV spectra from 200 nm to 400 nm.

dried over sodium sulfate. The solids are filtered off and the solvent is distilled off. The residue is purified by chromatography. This gives 2-chlorocyclohexyl 3-[2-(1-{[3,5-bis(difluoromethyl)-1H-pyrazol-1-yl]acetyl}piperidin-4-yl)-1,3-thiazol-4-yl]-4,5-dihydro-1,2-oxazole-5-carboxylate (100 mg, 50%).

log P (pH 2.7): 3.43

¹H NMR (DMSO-d₆, 400 MHz): δ_{ppm} : 1.29-2.21 (m, 12H), 2.78-2.89 (m, 2H), 3.54-3.63 (m, 1H), 3.75-3.88 (m, 1H), 3.92-4.03 (m, 1H), 4.06-4.17 (m, 1H), 4.30-4.39 (m, 1H), 4.78-4.86 (m, 1H), 5.24-5.47 (m, 3H), 6.89 (s, 1H), 7.02 (t, 1H), 7.16 (t, 1H), 8.08 (s, 1H)

MS (ESI): 606 ([M+H]⁺)

55

NMR Data of Selected Examples

55

NMR Peak List Method

The ¹H-NMR data of Examples I-1 to I-9 are noted in the form of ¹H-NMR peak lists (DMSO-d₆). For each signal peak, the δ value in ppm and the signal intensity in brackets are listed:

60

EXAMPLE I-1

8.7783 (1.07) 8.4335 (1.65) 8.0683 (5.48) 7.3089 (1.21)
7.1756 (2.75) 7.1706 (0.76) 7.1602 (1.5) 7.0424 (1.62)
7.0327 (0.44) 7.0242 (3.3) 6.9 (3.19) 6.8883 (1.96) 5.5064
(0.33) 5.4534 (0.5) 5.4102 (1.91) 5.3978 (0.5) 5.3687 (2.13)

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5.326 (0.54) 5.2942 (1.05) 5.2783 (1.34) 5.2651 (1.17)
 5.2491 (1.1) 4.3622 (0.55) 4.3248 (0.85) 4.3069 (1.24)
 4.2891 (1.16) 4.2715 (0.37) 4.0569 (0.47) 4.0391 (1.48)
 4.0213 (1.49) 4.0035 (0.59) 3.9826 (0.58) 3.9491 (0.63)
 3.7902 (1.08) 3.7591 (0.82) 3.7448 (1.43) 3.7119 (1.6) 3.6418
 (1.37) 3.6259 (1.39) 3.5983 (0.96) 3.5823 (1.43) 3.4154
 (0.41) 3.3958 (0.48) 3.3871 (0.79) 3.3776 (0.46) 3.3581
 (0.42) 3.3 (357.7) 3.2414 (0.67) 2.881 (0.39) 2.873 (0.41)
 2.849 (0.66) 2.8424 (0.66) 2.8151 (0.37) 2.6734 (0.48)
 2.6688 (0.67) 2.6642 (0.47) 2.5388 (0.68) 2.5221 (1.97)
 2.5173 (3.24) 2.5087 (38.98) 2.5043 (74.96) 2.4997 (99.82)
 2.4953 (68.34) 2.4908 (32.24) 2.3357 (0.37) 2.3311 (0.63)
 2.3265 (0.81) 2.3219 (0.6) 2.3173 (0.34) 2.1321 (0.66)
 2.0997 (125) 2.0846 (0.76) 2.0694 (1.47) 1.9867 (6.72)
 1.8391 (0.34) 1.8175 (0.62) 1.8096 (0.61) 1.7877 (0.63)
 1.6173 (0.35) 1.6079 (0.36) 1.5793 (0.59) 1.5559 (0.54)
 1.5471 (0.52) 1.3985 (1.44) 1.3197 (1.24) 1.3019 (2.6)
 1.2842 (1.25) 1.2367 (0.33) 1.1927 (1.95) 1.1748 (3.82)
 1.1571 (1.89)-0.0002 (2.15)

EXAMPLE I-2

8.7769 (0.81) 8.4701 (0.75) 8.0868 (6.22) 8.0799 (10.12)
 7.3077 (2.36) 7.1744 (5.45) 7.1593 (2.79) 7.0411 (2.65)
 7.0233 (6.62) 6.8999 (5.12) 6.8874 (3.24) 5.4528 (0.97)
 5.4099 (3.75) 5.3671 (3.81) 5.3205 (1.64) 5.3059 (2.17)
 5.2901 (2.97) 5.2766 (2.38) 5.2603 (1.8) 4.9071 (0.34)
 4.8953 (0.53) 4.8811 (0.91) 4.874 (0.86) 4.869 (1.12) 4.8599
 (1.03) 4.8477 (1.22) 4.8337 (0.52) 4.8213 (0.5) 4.6283 (0.61)
 4.6234 (0.34) 4.616 (0.62) 4.6073 (0.47) 4.6021 (0.68)
 4.5949 (0.45) 4.59 (0.57) 4.5812 (0.39) 4.5685 (0.34) 4.5011
 (0.54) 4.496 (0.35) 4.4888 (0.64) 4.4799 (0.42) 4.4749 (0.66)
 4.4676 (0.45) 4.4625 (0.61) 4.4539 (0.36) 4.4412 (0.36)
 4.3623 (1.03) 4.33 (1.1) 4.057 (1.13) 4.0392 (3.47) 4.0214
 (3.53) 4.0036 (1.3) 3.9835 (0.99) 3.9493 (1.09) 3.8384 (0.77)
 3.8216 (1.23) 3.8088 (0.91) 3.7946 (1.51) 3.7923 (1.7) 3.778
 (2.05) 3.7653 (1.01) 3.7486 (1.63) 3.6022 (1.86) 3.5857
 (1.85) 3.5589 (1.79) 3.5425 (1.7) 3.5171 (0.86) 3.5011 (0.82)
 3.4252 (0.45) 3.4167 (0.82) 3.4069 (0.6) 3.3974 (0.99)
 3.3879 (1.72) 3.3784 (1.01) 3.3689 (0.69) 3.3593 (1.05)
 3.3534 (0.62) 3.3519 (0.63) 3.3497 (0.73) 3.3468 (0.65)
 3.3453 (0.6) 3.3431 (0.69) 3.3423 (0.73) 3.3394 (0.84)
 3.3387 (0.86) 3.3379 (0.89) 3.3372 (0.91) 3.3365 (0.93)
 3.3358 (0.95) 3.3093 (1157.8) 3.2859 (4.56) 3.2691 (2.03)
 3.2397 (0.99) 2.8705 (0.73) 2.8407 (1.33) 2.8129 (0.72)
 2.6787 (0.33) 2.6741 (0.71) 2.6694 (0.98) 2.6648 (0.71)
 2.6602 (0.34) 2.5395 (1.39) 2.5228 (2.29) 2.5181 (3.44)
 2.5094 (51.39) 2.5049 (102.77) 2.5004 (140.72) 2.4959
 (96.35) 2.4914 (45.37) 2.3361 (0.37) 2.3317 (0.74) 2.3271
 (1.01) 2.3225 (0.73) 2.3179 (0.35) 2.1352 (0.99) 2.1003
 (2.13) 2.0691 (3.86) 2.0494 (1.49) 2.0211 (0.59) 2.0093
 (0.46) 1.9977 (0.39) 1.9868 (1.6) 1.9777 (0.56) 1.9719 (0.57)
 1.9569 (0.81) 1.9398 (0.93) 1.9318 (0.85) 1.9081 (0.4)
 1.8381 (0.44) 1.8161 (0.9) 1.808 (0.93) 1.7865 (0.88) 1.7779
 (0.81) 1.7568 (0.35) 1.6668 (1.04) 1.6612 (1.12) 1.6474 (1.2)
 1.638 (1.39) 1.6284 (1.3) 1.6188 (1.51) 1.6092 (1.51) 1.5862
 (1.25) 1.5771 (1.25) 1.5559 (1.47) 1.5471 (1.32) 1.5251
 (1.14) 1.5059 (0.71) 1.5003 (0.71) 1.4744 (0.33) 1.4305
 (0.34) 1.409 (0.9) 1.3984 (4.75) 1.3829 (0.97) 1.3533 (1.06)
 1.3459 (0.83) 1.3317 (1.43) 1.3268 (1.53) 1.3202 (1.19)
 1.3016 (2) 1.2706 (0.79) 1.2368 (0.46) 1.1928 (4.57) 1.175
 (9.03) 1.1572 (4.47) 0.008 (0.36)-0.0001 (12.1)-0.0085
 (0.39)

EXAMPLE I-3

7.9337 (9.17) 7.7849 (8.41) 7.3131 (2.83) 7.2308 (1.17)
 7.2264 (1.77) 7.2096 (5.45) 7.206 (4.65) 7.2006 (5) 7.1799

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(8.22) 7.1609 (3.49) 7.1486 (0.9) 7.1436 (1.97) 7.1391 (2.31)
 7.1233 (3.8) 7.1198 (3.73) 7.0906 (1.11) 7.0841 (1.43)
 7.0796 (0.8) 7.0701 (4.55) 7.0532 (4.82) 7.0484 (5.47)
 7.0318 (1.79) 7.0244 (6.65) 7.0146 (0.79) 6.9027 (5.9)
 6.8885 (3.48) 6.8765 (0.31) 5.4682 (1.22) 5.4254 (4.24)
 5.3777 (2.84) 5.3361 (0.95) 5.3066 (0.87) 5.0335 (0.48)
 5.0239 (1.92) 5.0091 (2.77) 4.994 (2.8) 4.9793 (2.96) 4.97
 (1.17) 4.9539 (0.63) 4.946 (1.87) 4.9302 (1.96) 4.9162 (1.91)
 4.9002 (1.66) 4.378 (1.23) 4.3434 (1.34) 4.0569 (1.06)
 4.0391 (3.24) 4.0213 (3.34) 4.0034 (2.07) 3.9645 (1.33)
 3.6161 (1.28) 3.5861 (1.49) 3.5728 (1.68) 3.5428 (1.33)
 3.4733 (1.24) 3.4431 (1.6) 3.4297 (2.02) 3.4181 (0.72)
 3.4091 (1.04) 3.3995 (2.61) 3.3909 (1.25) 3.3819 (1.42)
 3.3711 (1.24) 3.3629 (0.99) 3.3545 (1.13) 3.346 (1.12)
 3.3042 (2609.58) 3.2649 (2.09) 3.1759 (0.36) 3.1636 (0.31)
 3.0368 (2.29) 2.8903 (0.85) 2.8567 (2.73) 2.8497 (2.48)
 2.8406 (2.19) 2.8133 (1.56) 2.7973 (1.5) 2.7479 (0.52)
 2.7388 (0.6) 2.717 (0.98) 2.7084 (1.24) 2.6973 (0.76) 2.6905
 (0.76) 2.6785 (2.06) 2.6736 (2.89) 2.669 (3.72) 2.6645 (2.44)
 2.6598 (1.13) 2.651 (0.63) 2.6411 (0.59) 2.539 (3.97) 2.5223
 (7.24) 2.5176 (11.19) 2.5089 (158.52) 2.5045 (312.78) 2.5
 (423.07) 2.4955 (291.22) 2.491 (137.64) 2.4634 (2.02)
 2.4488 (1.62) 2.4326 (0.36) 2.3358 (1.08) 2.3313 (2.11)
 2.3267 (2.98) 2.322 (2.14) 2.3176 (1.09) 2.1467 (1.2) 2.1153
 (2.36) 2.0799 (1.36) 2.0691 (3.47) 2.0493 (0.95) 2.0189
 (1.51) 2.0096 (1.7) 1.9976 (1.58) 1.9867 (15) 1.8175 (2.41)
 1.7969 (3.45) 1.7266 (1.28) 1.6911 (1.4) 1.6654 (0.67)
 1.6278 (1.7) 1.5973 (2.23) 1.5658 (1.47) 1.5447 (0.6) 1.5373
 (0.53) 1.518 (0.6) 1.5103 (0.66) 1.486 (1.9) 1.4654 (2.76)
 1.4447 (1.61) 1.3985 (8.39) 1.3781 (0.66) 1.3555 (1.09)
 1.3496 (1.07) 1.3313 (0.73) 1.3235 (0.84) 1.317 (0.83)
 1.3017 (0.45) 1.2921 (0.49) 1.285 (0.34) 1.236 (0.87) 1.1926
 (4.09) 1.1748 (8.08) 1.1571 (4.03) 0.8885 (0.39) 0.8717
 (0.43) 0.0081 (1.19)-0.0001 (34.78)-0.0083 (1.13)

EXAMPLE I-4

10.7328 (0.4) 9.003 (0.32) 8.7769 (0.84) 8.6923 (0.56)
 8.6796 (0.59) 8.505 (0.42) 8.2225 (0.43) 8.2104 (0.4) 8.0753
 (7.22) 8.0651 (6.28) 7.9976 (0.38) 7.9927 (0.67) 7.9874
 (0.41) 7.6637 (0.61) 7.3072 (1.98) 7.2908 (0.4) 7.2828 (0.33)
 7.1738 (4.52) 7.159 (2.85) 7.1485 (0.77) 7.0405 (2.25) 7.023
 (6.11) 7.0128 (0.74) 6.9573 (0.39) 6.8996 (5.18) 6.8871
 (3.34) 6.8767 (0.5) 6.8416 (0.32) 5.7462 (2.71) 5.4516 (0.85)
 5.4082 (3.26) 5.389 (0.55) 5.3668 (3.47) 5.3498 (1.27)
 5.3339 (2.22) 5.3264 (16) 5.3119 (15.12) 5.3047 (2.36) 5.296
 (1.74) 5.2795 (1.48) 4.9718 (0.49) 4.9613 (0.75) 4.9483 (1.2)
 4.9377 (1.34) 4.9249 (0.76) 4.9142 (0.63) 4.357 (0.94)
 4.3249 (1) 3.9835 (0.9) 3.9483 (1) 3.8795 (0.73) 3.8495
 (1.69) 3.8359 (1.2) 3.8196 (1.03) 3.8058 (2.26) 3.776 (1.15)
 3.7121 (0.78) 3.6228 (1.26) 3.6097 (1.3) 3.6064 (147) 3.5939
 (1.03) 3.5793 (0.96) 3.5659 (0.94) 3.563 (1.03) 3.5502 (1.09)
 3.547 (1.08) 3.5037 (0.86) 3.4896 (1.23) 3.4792 (2.82)
 3.4652 (2.5) 3.4551 (2.95) 3.4452 (1.17) 3.441 (1.29) 3.4311
 (1.01) 3.4164 (0.53) 3.4075 (0.33) 3.3965 (0.61) 3.3874 (1.2)
 3.3785 (0.61) 3.3593 (0.42) 3.3083 (1161.47) 3.2848 (14.7)
 3.2404 (1.48) 3.1922 (0.53) 3.1631 (0.45) 3.1104 (0.4)
 3.0883 (0.66) 3.0784 (0.73) 3.0596 (1.11) 3.0503 (1.21)
 3.037 (2.66) 3.0257 (1.33) 3.0079 (0.72) 2.9978 (0.75)
 2.8727 (0.8) 2.8498 (2.34) 2.8153 (0.79) 2.6786 (0.42)
 2.6743 (0.91) 2.6695 (1.27) 2.6649 (0.95) 2.5395 (1.15)
 2.5228 (2.6) 2.5181 (4.06) 2.5094 (67.94) 2.5049 (137.72)
 2.5004 (190.11) 2.4959 (133.69) 2.4914 (65.57) 2.4781
 (5.44) 2.4639 (3.86) 2.4589 (4.38) 2.4542 (4.05) 2.4495
 (4.08) 2.4352 (3.38) 2.4258 (3.37) 2.4019 (0.4) 2.3364 (0.63)
 2.3317 (1.08) 2.3272 (1.46) 2.3225 (1.12) 2.3179 (0.62)
 2.1375 (1.08) 2.1002 (2.05) 2.0691 (3.74) 2.0552 (1.84)

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2.0496 (1.5) 2.0275 (1.16) 2.0175 (1.35) 2.01 (1.74) 2.001
 (2.88) 1.9962 (2.84) 1.9919 (3.01) 1.9868 (3.03) 1.9774
 (2.08) 1.9728 (1.7) 1.968 (2.87) 1.9637 (3.32) 1.9589 (3.21)
 1.9542 (3.34) 1.9452 (2.06) 1.9368 (1.46) 1.9262 (1.08)
 1.9072 (0.74) 1.8988 (0.42) 1.8503 (2.74) 1.8406 (2.94)
 1.8298 (2.68) 1.8196 (2.94) 1.816 (3.15) 1.8094 (3.43) 1.801
 (2) 1.7811 (0.99) 1.7665 (0.55) 1.7558 (0.49) 1.7169 (0.61)
 1.7077 (0.8) 1.688 (1.54) 1.6798 (2.02) 1.6539 (3.07) 1.6467
 (3.42) 1.6363 (2.54) 1.6261 (3.34) 1.6179 (3.79) 1.6132
 (3.95) 1.6084 (3.26) 1.6036 (2.66) 1.5862 (3.33) 1.5773
 (4.07) 1.5688 (2.83) 1.5549 (3.01) 1.5512 (2.81) 1.5453
 (3.58) 1.5359 (2.71) 1.5272 (1.36) 1.517 (2.75) 1.508 (1.2)
 1.4885 (4.32) 1.485 (2.66) 1.4797 (2.78) 1.4595 (2.79)
 1.4559 (3.99) 1.4507 (2.33) 1.4471 (2.73) 1.4268 (2.3)
 1.4179 (2.4) 1.3911 (2.58) 1.3677 (1.64) 1.3385 (0.56)
 1.2977 (1.21) 1.2894 (1.6) 1.2813 (1.33) 1.2676 (2.38)
 1.2597 (3.64) 1.2519 (2.05) 1.2373 (3.58) 1.2301 (4.87)
 1.2234 (2.57) 1.2113 (1.92) 1.2026 (5.84) 1.1929 (2.7)
 1.1879 (3.07) 1.1798 (4.5) 1.1729 (3.71) 1.1601 (3.51)
 1.1556 (3.55) 1.1483 (3.46) 1.1428 (1.94) 1.1309 (2.82)
 1.1251 (1.9) 1.1176 (1.45) 1.1101 (0.7) 1.1012 (0.97) 1.0922
 (0.6) 0.008 (0.54)-0.0001 (16.73)-0.0083 (0.65)

EXAMPLE I-5

8.7769 (0.4) 8.0798 (8.92) 8.0773 (15) 7.3066 (3.02)
 7.2814 (0.5) 7.1733 (6.93) 7.1591 (3.75) 7.1483 (1.76) 7.04
 (3.4) 7.023 (8.79) 7.0126 (1.5) 6.8996 (6.79) 6.8872 (4.99)
 6.8767 (0.73) 5.4519 (1.33) 5.4087 (5.01) 5.3661 (5.05)
 5.3366 (1.55) 5.3209 (2.68) 5.3066 (4.04) 5.2978 (2.72)
 5.2911 (1.63) 5.2815 (3.17) 5.2684 (2.92) 5.2519 (2.62)
 4.8489 (0.9) 4.8381 (1.65) 4.8253 (1.9) 4.8147 (2.66) 4.8015
 (1.28) 4.7902 (1.3) 4.3596 (1.45) 4.3294 (1.49) 4.1628 (0.51)
 4.1514 (0.7) 4.135 (0.78) 4.1277 (1.61) 4.1166 (1.3) 4.101
 (1.86) 4.0935 (1.45) 4.0779 (1.06) 4.0664 (1.15) 4.0568
 (1.01) 4.039 (2.73) 4.0212 (2.73) 4.0033 (1.07) 3.9817 (1.41)
 3.9472 (1.51) 3.8598 (0.86) 3.838 (1.79) 3.8303 (1.28)
 3.8164 (1.6) 3.8083 (2.23) 3.7943 (3.07) 3.7872 (1.39)
 3.7651 (2.38) 3.6133 (3.28) 3.5968 (3.41) 3.5698 (2.32)
 3.5535 (2.49) 3.4248 (0.81) 3.4159 (1.44) 3.3961 (1.91)
 3.3875 (2.76) 3.3767 (2.17) 3.3683 (2.29) 3.3568 (3.33)
 3.3093 (7524.94) 3.2766 (6.54) 3.2729 (6.7) 3.2472 (2.11)
 3.2428 (2.3) 3.2135 (0.88) 3.2002 (0.74) 3.1822 (0.68)
 3.1632 (0.64) 3.1302 (0.47) 3.0802 (0.35) 3.0613 (0.35)
 3.055 (0.36) 3.0368 (7.05) 3.0216 (0.36) 2.9608 (0.32)
 2.9368 (0.32) 2.8903 (0.56) 2.872 (1.16) 2.8495 (6.62)
 2.8129 (1.11) 2.7309 (0.33) 2.6949 (0.56) 2.6784 (2.06)
 2.674 (4.46) 2.6693 (6.13) 2.6647 (4.47) 2.6599 (2.13)
 2.5393 (8.67) 2.5227 (14.86) 2.5179 (22.21) 2.5092 (324.46)
 2.5048 (648.61) 2.5003 (887.69) 2.4958 (611.23) 2.4913
 (289.86) 2.4386 (0.65) 2.4052 (0.36) 2.3859 (0.33) 2.3722
 (0.33) 2.3361 (2.1) 2.3316 (4.39) 2.327 (6.19) 2.3223 (4.46)
 2.3178 (2.2) 2.2075 (0.37) 2.1913 (1.03) 2.1793 (1.42)
 2.1727 (1.31) 2.1478 (2.18) 2.1372 (2.21) 2.099 (2.87) 2.069
 (5.51) 2.0494 (2.12) 2.0312 (0.34) 2.0087 (1.17) 1.9977
 (1.34) 1.9867 (13.38) 1.9793 (1.76) 1.9402 (0.37) 1.9254
 (0.32) 1.9075 (1.26) 1.8405 (0.66) 1.8051 (1.29) 1.7831
 (1.28) 1.7399 (0.83) 1.7332 (0.79) 1.7128 (1.48) 1.704 (1.51)
 1.6725 (4.02) 1.653 (3.19) 1.6438 (2.94) 1.5753 (1.38)
 1.5546 (1.21) 1.5455 (1.24) 1.5226 (0.57) 1.5111 (0.5)
 1.4996 (0.32) 1.4832 (0.59) 1.4538 (1.28) 1.4285 (2.55)
 1.3985 (4.15) 1.3726 (2.17) 1.3463 (1.75) 1.3138 (0.92)
 1.2924 (0.69) 1.2647 (0.38) 1.2586 (0.36) 1.2365 (1.58)
 1.1926 (3.56) 1.1749 (7.02) 1.157 (3.5) 1.1518 (0.54) 1.0703
 (0.49) 0.008 (0.44)-0.0001 (14.82)-0.0083 (0.39)

EXAMPLE I-6

19.1128 (0.36) 17.393 (0.35) 16.9053 (0.37) 16.5966
 (0.34) 14.3354 (0.34) 8.7772 (1.51) 8.4106 (1.87) 8.0749

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(12.87) 8.0722 (14.62) 7.6634 (1.05) 7.3898 (0.87) 7.381
 (0.89) 7.3678 (1.13) 7.344 (0.42) 7.3082 (3.98) 7.2812 (2.81)
 7.262 (3.86) 7.2577 (3.83) 7.2537 (2.86) 7.2474 (4.08)
 7.2392 (3.41) 7.2357 (2.43) 7.2299 (4.6) 7.1963 (2.62)
 7.1875 (3.02) 7.175 (11.76) 7.1674 (7.41) 7.1603 (7.46)
 7.1485 (4.65) 7.1359 (1.8) 7.133 (1.79) 7.1234 (2.3) 7.1165
 (1.55) 7.1103 (1.54) 7.0982 (0.74) 7.0846 (0.46) 7.0417
 (5.24) 7.0346 (2.19) 7.0242 (11.69) 6.9879 (0.5) 6.9607
 (0.59) 6.9504 (0.45) 6.9296 (0.49) 6.9004 (9.18) 6.8883
 (5.82) 6.8768 (0.64) 6.853 (0.56) 6.8335 (0.4) 6.8243 (0.42)
 6.7725 (0.34) 6.1256 (0.42) 5.9626 (1.35) 5.951 (3.48)
 5.9378 (3.9) 5.9258 (1.37) 5.4526 (1.68) 5.41 (6.26) 5.3908
 (0.97) 5.3678 (6.61) 5.324 (1.8) 5.3061 (1.29) 5.2886 (2.07)
 5.279 (2.6) 5.2723 (2.64) 5.2625 (3.41) 5.2597 (2.6) 5.2498
 (2.74) 5.2431 (2.12) 5.2335 (2.43) 5.1282 (0.37) 5.0532
 (0.37) 5.0361 (0.4) 5.0303 (0.36) 4.5584 (0.78) 4.5424 (0.5)
 4.3619 (2.01) 4.329 (2.25) 4.2786 (0.48) 4.172 (0.35) 4.1611
 (0.41) 4.0569 (0.7) 4.0391 (1.98) 4.0212 (2.31) 4.0033 (0.96)
 3.9798 (1.88) 3.9459 (2.21) 3.9059 (0.34) 3.829 (0.44)
 3.8098 (0.37) 3.7978 (1.35) 3.7841 (1.8) 3.7686 (1.58)
 3.7632 (0.69) 3.7544 (4.27) 3.7404 (2.84) 3.7251 (2.21)
 3.7115 (2.68) 3.685 (0.61) 3.6281 (2.29) 3.6109 (4.46)
 3.5936 (2.79) 3.5849 (1.74) 3.5676 (3.05) 3.5499 (2.45)
 3.5471 (2.46) 3.5259 (0.53) 3.5069 (0.48) 3.4906 (0.6) 3.483
 (0.54) 3.4151 (1.84) 3.3957 (2.67) 3.3866 (3.78) 3.3767
 (3.35) 3.3678 (2.59) 3.3582 (4.26) 3.3074 (4729.97) 3.278
 (6.72) 3.2496 (2.16) 3.2415 (2.27) 3.1987 (0.68) 3.1755
 (0.41) 3.1619 (0.43) 3.1375 (0.43) 3.1119 (0.44) 3.089 (0.41)
 3.06 (0.35) 3.0369 (3.1) 3.0197 (0.38) 2.899 (0.41) 2.8906
 (0.74) 2.8717 (1.42) 2.8494 (4.81) 2.815 (2.88) 2.8025 (3.15)
 2.7879 (1.74) 2.7505 (1.71) 2.7317 (2.24) 2.7103 (2) 2.6949
 (1.58) 2.6785 (2.47) 2.6738 (5.15) 2.6692 (6.58) 2.6646
 (4.82) 2.6601 (2.66) 2.6154 (0.76) 2.5984 (0.69) 2.577 (0.77)
 2.5392 (8.23) 2.5225 (16.89) 2.5178 (25.25) 2.5091 (315.14)
 2.5047 (618.23) 2.5002 (835.42) 2.4957 (569.99) 2.4912
 (265.67) 2.4276 (0.36) 2.3359 (1.94) 2.3315 (3.97) 2.327
 (5.42) 2.3223 (4.08) 2.3177 (1.86) 2.1862 (0.36) 2.1303
 (1.94) 2.0993 (3.64) 2.069 (16) 2.0494 (2.19) 2.0311 (0.96)
 2.0091 (1.41) 1.9976 (2.37) 1.9867 (10.67) 1.9741 (3.56)
 1.963 (5) 1.9511 (3.48) 1.9386 (1.56) 1.9248 (1.2) 1.914
 (1.05) 1.8986 (1.14) 1.8736 (1.47) 1.8691 (1.51) 1.8485
 (1.98) 1.8393 (2.22) 1.8245 (2.68) 1.8094 (3.96) 1.7966 (3.4)
 1.783 (3.9) 1.7493 (1.3) 1.7112 (0.56) 1.6925 (1) 1.6773
 (1.02) 1.671 (1.07) 1.6537 (1.14) 1.6049 (1) 1.5785 (1.73)
 1.5555 (1.73) 1.5458 (1.76) 1.5269 (1.13) 1.493 (0.53)
 1.4651 (0.37) 1.4056 (0.39) 1.3985 (2.95) 1.3615 (0.38)
 1.3487 (0.37) 1.2937 (0.47) 1.2796 (0.44) 1.259 (0.72)
 1.2363 (1.75) 1.1926 (2.45) 1.1748 (5.09) 1.1571 (2.75)
 1.1107 (0.36) 1.0372 (0.34) 1.0183 (0.43) 0.9995 (0.36)
 0.8967 (0.38) 0.8884 (1.16) 0.8781 (0.61) 0.8716 (1.12)
 0.8587 (0.49) 0.1454 (0.37) 0.0593 (1.72) 0.008 (3.52)-
 0.0001 (103.04)-0.0085 (3.3)-0.1494 (0.5)-0.842 (0.35)-
 2.6762 (0.35)-3.4649 (0.34)

EXAMPLE I-7

8.7765 (0.48) 8.0716 (16) 7.5675 (0.68) 7.5507 (1.48)
 7.5463 (1.31) 7.5339 (0.93) 7.5296 (2.92) 7.5253 (1.03)
 7.5129 (1.33) 7.5084 (1.71) 7.4918 (0.78) 7.308 (2.31)
 7.2024 (0.46) 7.1985 (0.64) 7.1893 (4.3) 7.1746 (6.03)
 7.1692 (6.82) 7.1597 (3.28) 7.1488 (3.71) 7.1392 (0.57)
 7.0414 (2.6) 7.0236 (6.28) 6.9005 (4.67) 6.8877 (3.03)
 5.4518 (0.93) 5.4092 (3.52) 5.3671 (3.63) 5.3241 (1.01)
 5.3156 (2.83) 5.2997 (3.5) 5.2864 (3.18) 5.2705 (9.89)
 5.2384 (0.61) 4.359 (1.01) 4.3255 (1.06) 4.0569 (0.61)
 4.0391 (1.84) 4.0213 (1.88) 4.0036 (0.71) 3.9817 (0.97)
 3.946 (1.13) 3.7901 (1.92) 3.7608 (2.19) 3.7465 (3.28)

3.7173 (2.65) 3.6029 (3.06) 3.5869 (3.11) 3.5594 (2.16)
 3.5435 (2.11) 3.4225 (0.61) 3.413 (1.06) 3.4041 (0.84)
 3.3939 (1.3) 3.3843 (2.09) 3.3741 (1.56) 3.3557 (2.19)
 3.3131 (3081.89) 3.2897 (10.95) 3.2715 (2.41) 3.2494 (0.77)
 3.2398 (1.03) 2.8786 (0.63) 2.8721 (0.75) 2.8435 (1.27)
 2.8138 (0.7) 2.6788 (0.73) 2.6743 (1.6) 2.6697 (2.24) 2.665
 (1.62) 2.6605 (0.77) 2.5397 (3.33) 2.523 (5.48) 2.5183 (8.17)
 2.5096 (116.16) 2.5051 (231.84) 2.5006 (317.64) 2.4961
 (217.01) 2.4916 (102.18) 2.3365 (0.71) 2.332 (1.56) 2.3273
 (2.2) 2.3227 (1.57) 2.3183 (0.67) 2.1317 (0.93) 2.0979 (1.86)
 2.0689 (4.95) 2.0494 (1.11) 1.9867 (8.34) 1.8436 (0.35)
 1.8345 (0.42) 1.8138 (0.81) 1.8057 (0.89) 1.7838 (0.81)
 1.7768 (0.74) 1.7534 (0.33) 1.614 (0.33) 1.6031 (0.41)
 1.5816 (0.82) 1.5739 (0.87) 1.5517 (0.82) 1.5436 (0.74)
 1.5215 (0.33) 1.3984 (2.8) 1.2399 (0.63) 1.2368 (0.58)
 1.2229 (0.41) 1.1928 (2.37) 1.1749 (4.81) 1.1572 (2.37)-
 0.0001 (6.12)

EXAMPLE I-8

8.7992 (0.48) 8.7843 (0.97) 8.7696 (0.49) 8.0814 (5.74)
 7.443 (0.62) 7.4374 (1) 7.4307 (0.77) 7.4276 (0.81) 7.4239
 (0.71) 7.419 (1.05) 7.3092 (1.07) 7.3042 (0.74) 7.2906 (5.07)
 7.287 (2.53) 7.2824 (3.92) 7.2737 (1.03) 7.1761 (2.15) 7.16
 (1.05) 7.0428 (1.04) 7.0239 (2.49) 6.9004 (1.94) 6.888 (1.2)
 5.7464 (16) 5.4533 (0.36) 5.4107 (1.44) 5.37 (1.47) 5.3276
 (0.37) 5.229 (0.91) 5.2125 (1.19) 5.2009 (1.03) 5.1842 (0.97)
 4.3849 (2.87) 4.3699 (3.12) 4.3291 (0.44) 3.9859 (0.38)
 3.9522 (0.43) 3.7376 (0.57) 3.7092 (0.65) 3.6944 (1.32)
 16662 (1.07) 3.6259 (1.17) 3.6092 (1.26) 3.5826 (0.64)
 3.5661 (0.6) 3.4219 (0.33) 3.4032 (0.38) 3.3936 (0.68) 3.384
 (0.4) 3.3649 (0.39) 3.307 (224.31) 3.2835 (0.84) 3.2735
 (0.71) 3.2454 (0.33) 2.847 (0.51) 2.5226 (0.66) 2.5179 (1.01)
 2.5092 (13.72) 2.5048 (27.07) 2.5002 (36.66) 2.4958 (25.11)
 2.4913 (11.74) 2.1399 (0.36) 2.107 (0.76) 2.0691 (0.88)
 1.9868 (1.3) 1.8242 (0.33) 1.8164 (0.34) 1.594 (0.33) 1.5848
 (0.35) 1.5645 (0.34) 1.5552 (0.32) 1.1927 (0.37) 1.1749
 (0.73) 1.1571 (0.36)-0.0001 (5.31)

EXAMPLE I-9

8.8772 (0.36) 8.8371 (1.19) 8.8228 (2.79) 8.8082 (1.32)
 8.2158 (1.73) 8.0772 (16) 8.0284 (0.33) 8.0075 (0.36) 7.7383
 (0.38) 7.6473 (0.41) 7.6415 (0.53) 7.6334 (2.32) 7.6282
 (2.45) 7.6143 (1) 7.609 (1.08) 7.5968 (8.19) 7.5917 (7.34)
 7.5753 (3.12) 7.5438 (0.35) 7.5346 (0.43) 7.525 (0.45) 7.508
 (0.49) 7.5007 (2.11) 7.4955 (1.84) 7.4798 (1.37) 7.4746
 (1.31) 7.4598 (0.44) 7.454 (0.55) 7.4498 (0.46) 7.44 (0.44)
 7.4287 (0.87) 7.4237 (0.97) 7.4068 (4.26) 7.4015 (3.75)
 7.3859 (4.62) 7.3805 (4.68) 7.3477 (1.08) 7.3295 (1.09)
 7.3108 (7.26) 7.2901 (3.9) 7.1753 (5.74) 7.1594 (2.95)
 7.0421 (2.93) 7.0234 (6.97) 6.9003 (5.55) 6.8875 (3.43)
 6.341 (0.32) 5.4507 (1.09) 5.4093 (3.85) 5.3695 (4.24)
 5.3268 (1.1) 5.2193 (2.43) 5.2031 (3.05) 5.191 (2.59) 5.1745
 (2.53) 4.9071 (0.58) 4.5418 (0.35) 4.5108 (0.7) 4.4962 (0.74)
 4.3811 (0.74) 4.3548 (5.26) 4.3363 (5.18) 4.3116 (0.72)
 4.2833 (1.37) 4.2687 (1.34) 4.2593 (0.4) 4.191 (0.37) 4.1065
 (0.33) 4.0328 (0.34) 4.0012 (0.74) 3.9789 (2.02) 3.9485
 (1.52) 3.933 (6.63) 3.8871 (0.4) 3.8696 (0.42) 3.8596 (0.51)
 3.8443 (0.39) 3.8356 (0.48) 3.8113 (0.41) 3.8028 (0.41)
 3.7896 (0.49) 3.7492 (0.71) 3.7347 (1.96) 3.7061 (2.31)
 3.6914 (3.82) 3.663 (3.32) 3.6139 (3.47) 3.5975 (3.58)
 3.5703 (2.32) 3.5596 (1.29) 3.5544 (2.37) 3.5371 (1.12)
 3.4987 (0.76) 3.4892 (0.94) 3.4757 (1.22) 3.4612 (0.98)
 3.4457 (0.98) 3.4206 (1.88) 3.4015 (2.37) 3.392 (3.44) 3.382
 (2.87) 3.3725 (3) 3.3108 (3647.99) 3.2873 (63.99) 3.2442
 (1.36) 2.8768 (1.06) 2.849 (1.64) 2.819 (0.95) 2.7518 (0.7)

2.7331 (0.33) 2.6951 (0.53) 2.6789 (1.62) 2.6742 (3.15)
 2.6696 (4.46) 2.665 (3.14) 2.6604 (1.49) 2.6373 (0.57)
 2.6256 (0.53) 2.5396 (6.88) 2.5229 (12.65) 2.5182 (18.74)
 2.5095 (230.52) 2.505 (453.99) 2.5005 (618.72) 2.496
 (419.29) 2.4914 (195.01) 2.3367 (1.22) 2.3318 (2.88) 2.3273
 (3.97) 2.3226 (2.9) 2.3179 (1.25) 2.1549 (0.51) 2.142 (1.18)
 2.1048 (2.11) 2.0692 (9.97) 2.0495 (1.01) 1.9356 (0.36)
 1.9181 (0.51) 1.9079 (0.59) 1.8965 (6.08) 1.8798 (0.37)
 1.8432 (0.65) 1.8123 (1.14) 1.7824 (1.01) 1.751 (0.57)
 1.7308 (0.33) 1.6668 (0.43) 1.6517 (0.49) 1.6139 (0.8) 1.593
 (1.07) 1.5823 (1.08) 1.5528 (0.93) 1.5217 (0.4) 1.3982 (0.51)
 1.3561 (0.58) 1.2357 (1.15) 1.1954 (0.33) 1.1251 (0.64)
 1.1065 (1.25) 1.0879 (0.51) 0.008 (1.62)-0.0001 (50.3)-
 0.0084 (1.51)

15 The intensity of sharp signals correlates with the height of
 the signals in a printed example of an NMR spectrum in cm
 and shows the true ratios of the signal intensities. In the case
 of broad signals, several peaks or the middle of the signal and
 their relative intensities may be shown in comparison to the
 most intense signal in the spectrum.

20 The lists of the ¹H NMR peaks are similar to the conven-
 tional ¹H NMR printouts and thus usually contain all peaks
 listed in conventional NMR interpretations.

In addition, like conventional ¹H NMR printouts, they may
 show solvent signals, signals of stereoisomers of the target
 compounds, which likewise form part of the subject-matter of
 the invention, and/or peaks of impurities.

In the reporting of compound signals in the delta range of
 solvents and/or water, our lists of ¹H NMR peaks show the
 usual solvent peaks, for example peaks of DMSO in DMSO-
 d₆ and the peak of water, which usually have a high intensity
 on average.

The peaks of stereoisomers of the target compounds and/or
 peaks of impurities usually have a lower intensity on average
 than the peaks of the target compounds (for example with a
 purity of >90%).

35 Such stereoisomers and/or impurities may be typical of the
 particular preparation process. Their peaks can thus help to
 identify reproduction of our preparation process with refer-
 ence to "by-product fingerprints".

40 An expert calculating the peaks of the target compounds by
 known methods (Mestrec, ACD simulation, but also with
 empirically evaluated expected values) can, if required, iso-
 late the peaks of the target compounds, optionally using addi-
 tional intensity filters. This isolation would be similar to the
 relevant peak picking in conventional ¹H NMR interpreta-
 tion.

The table lists all NMR data, both for the end compounds
 and for the intermediates.

USE EXAMPLES

Phytophthora Test (Tomato)/Protective

55 Solvent: 24.5 parts by weight of acetone
 24.5 parts by weight of dimethylacetamide
 Emulsifier: 1 part by weight of alkylaryl polyglycol ether
 To produce an appropriate active ingredient formulation, 1
 part by weight of active ingredient is mixed with the specified
 amounts of solvent and emulsifier, and the concentrate is
 diluted with water to the desired concentration.

60 To test for protective efficacy, young plants are sprayed
 with the active ingredient formulation at the stated applica-
 tion rate. After the spray coating has dried on, the plants are
 inoculated with an aqueous spore suspension of *Phytoph-*
thora infestans. The plants are then placed in an incubation
 cabin at approx. 20° C. and 100% relative air humidity.

79

Evaluation follows 3 days after the inoculation. 0% means an efficacy which corresponds to that of the control, whereas an efficacy of 100% means that no infection is observed.

In this test, the following inventive compounds show, at an active ingredient concentration of 10 ppm, an efficacy of 70% or more:

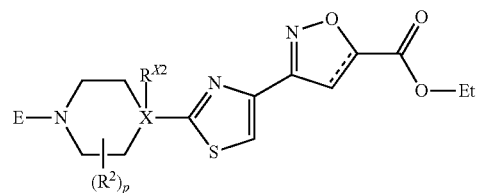
BCS code	Eff
I-5	93
I-3	91
I-7	91
I-8	96
I-2	70
I-6	95
I-9	98
I-4	94
I-1	75

The invention claimed is:

1. A compound of formula (XXXVIII), or a salt, a metal complex or a N-oxide thereof

80

(XXXVIII)



wherein

E is acetyl, C₁-C₄-alkoxycarbonyl or benzyloxycarbonyl,

X is carbon or nitrogen,

R^{X2} is hydrogen,

R² is oxo, alkyl, alkenyl, haloalkyl, alkoxy, halogen, cyano or hydroxyl,

and

p is 0.

2. The compound of according to claim 1,

wherein

X is carbon, and

R^{X2} is hydrogen.

* * * * *